

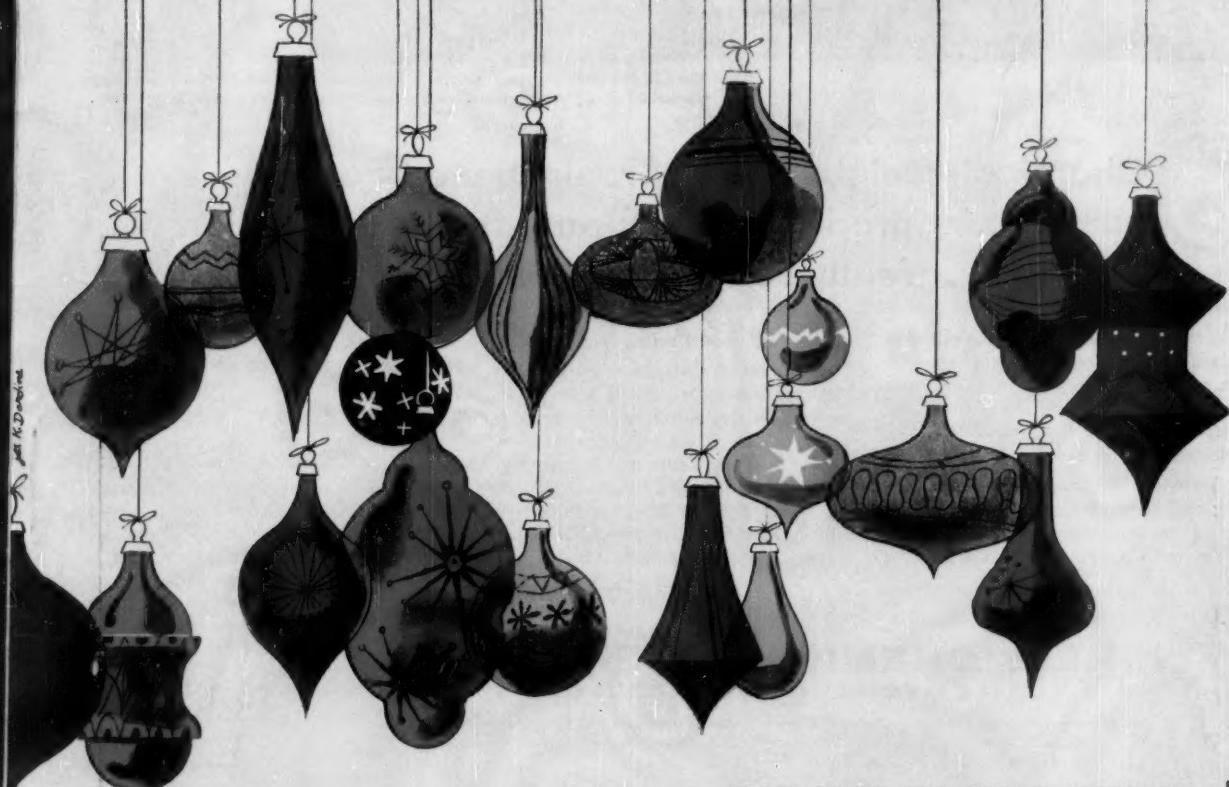
Chemical Engineering

A McGRAW-HILL PUBLICATION

DECEMBER 29, 1958

Published every-other-Monday

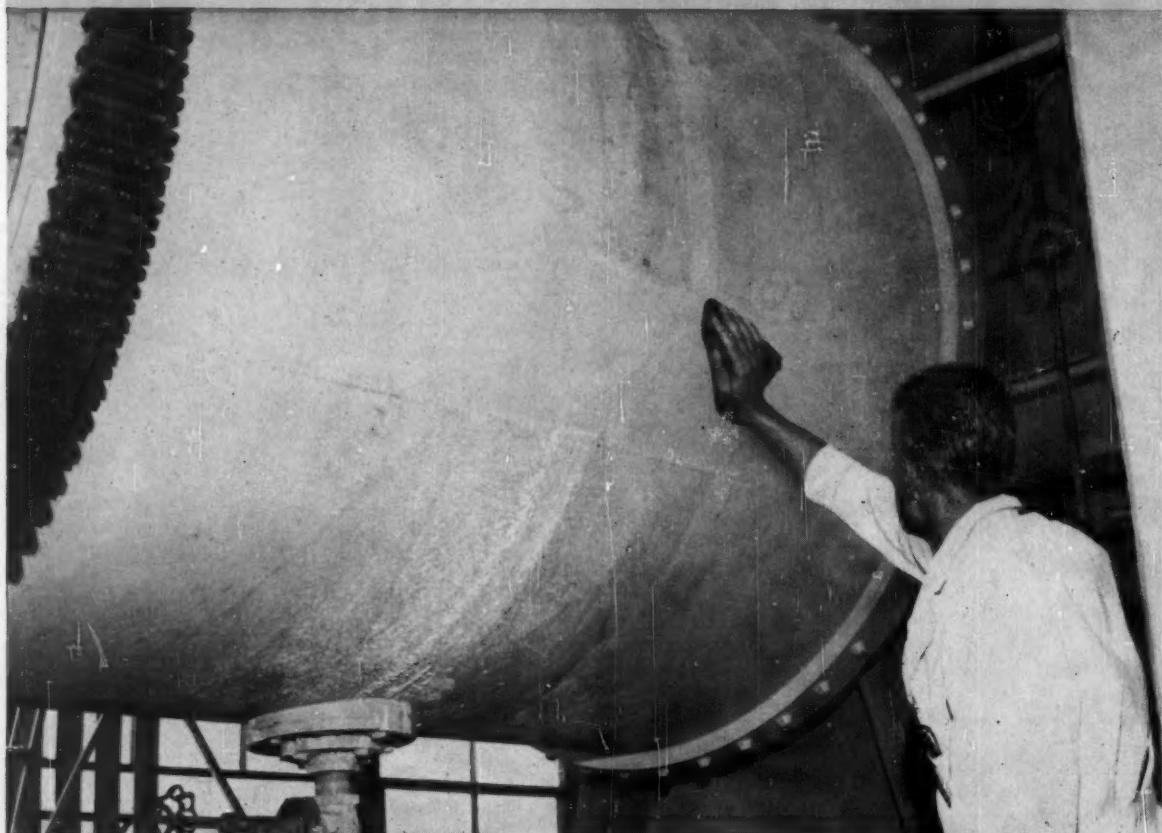
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COSTS OF SOLVENT RECOVERY SYSTEMS
MEDLEY OF SALARY DATA FOR 1958
ANNUAL EDITORIAL INDEX



At The Glidden Company...



At The Glidden Company, paint drippings from a pebble and steel ball mill are easily cleaned off the Epon resin-based exterior surface coating with a solvent-dipped rag.

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Epon resin-based paint, Nu-Pon Cote.

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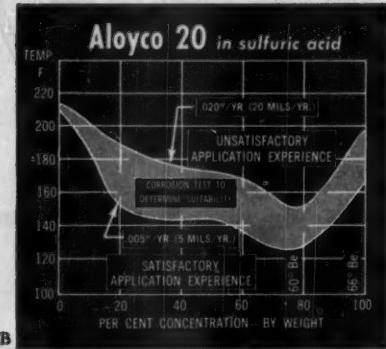
Most paint users are already aware of the many advantages offered by Epon resin formulations . . . excellent adhesion, resistance to abrasion, impact, heat, and humidity extremes.

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B

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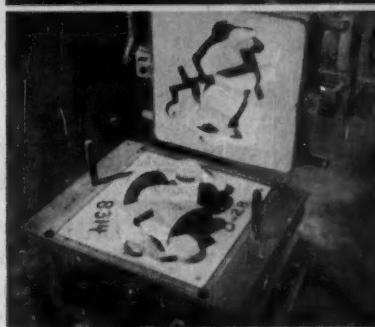
C. Valve Casting is made from Aloyco design in Aloyco foundry, only foundry ever built to produce pressure-tight Stainless Steel Valve castings, exclusively.

D. Special Techniques in machining stainless steel, plus most modern equipment in Aloyco plant assure you precise tolerances, trouble-free performance.

E. Aloyco Y Valve, shown here in various stages of production, is one of Aloyco's complete line of valve types, alloys, sizes, pressures—including nuclear valves.



A



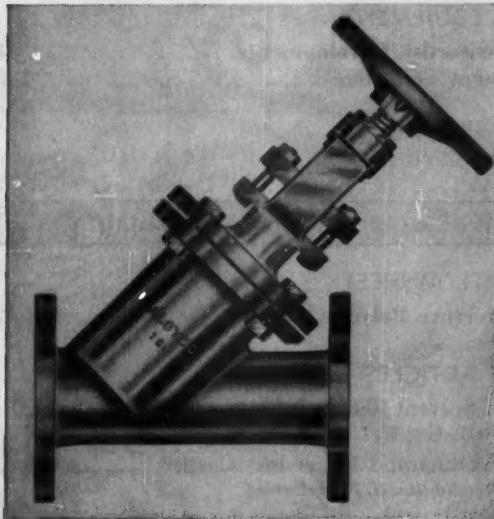
C



D

BEHIND EVERY ALOYCO VALVE... specialization

... to help you handle corrosives



Valves often look alike—even stainless steel valves. But they won't necessarily perform alike when you get them into the line.

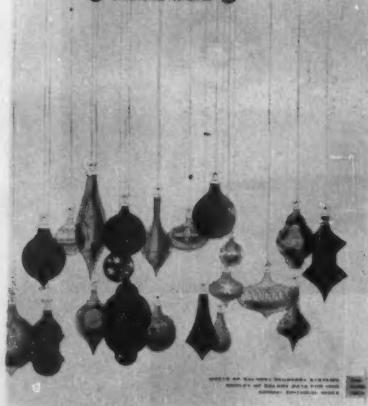
Here are some of the special skills and facilities that make the difference between Aloyco valves and others. Some of the "extras" you get with Aloyco valves are staying power, minimum maintenance, trouble-free operation in severe as well as mild corrosive service. Doesn't it make sense that the one company specializing in the manufacture of Stainless Steel Valves exclusively is your best source of supply?



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Chemical Engineering



TWENTY-SIXTH OF TWENTY-SIX ISSUES

26/26

How much for a solvent recovery system?

Right from charts, here are the answers for your preliminary estimates. New method estimates costs of building a carbon-adsorption solvent recovery plant and the cost of running it. Also, you can determine the feasibility of solvent recovery for your specific problems. (p. 51)

How to deal with cost of byproducts

Standard methods don't always work. Here's a better way to figure costs when you're dealing with byproducts or coproducts. It's based on engineering know-how to help you allocate joint costs—a common problem in controlling process operations. (p. 61)

A potpourri of salary optimism

A 1958 income miscellany reveals five encouraging facts: A five-year course really pays off; our industry pays better than average; ceramic engineers do very well; so do biologists; graduates at the University of Michigan did better in 1958 than in 1957. (p. 67)

Your annual index and reference . . .

Annual editorial index of Chemical Engineering proves that 26 issues brought you more news, more helpful articles, more everything. There are 2,308 listings as compared with 1,955 in pre-recession 1957. (p. 81)

Chemical

DECEMBER 29, 1958

Developments in Chemical Engineering

CHEMMENTATOR

Three Refiners Vote for Penex Process	17
Superphos Acid to get U. S. Producer	17
How to Make Modernization Pay Off	19
Spotlight on Soda Ash From Trona	19
Gas Turbines Score Economic Coup	19
How Dusts Synergize Pollution Hazards	22
Cheaper Structures Via Plastic Design	22

PROCESSES & TECHNOLOGY

Intense Arc Pierces Temperature Barrier	24
Information Retrieval Finds It in Minutes	28

CHEMICAL ECONOMICS

P ₂ O ₅ Is Making the News in Fertilizers	32
---	----

CHEMICAL PRODUCTS

10 Newsworthy Chemicals and Raw Materials	36
---	----

PROCESS EQUIPMENT

20 Newsworthy Developments	38
Equipment Cost Index	103

Practice of Chemical Engineering

PROCESS FLOWSHEET

High-Pressure Polyethylene Process Persists	42
---	----

FEATURE ARTICLES

Costs of Solvent Recovery Systems	51
<i>H. L. Barnebey, W. L. Davis</i>	
Joint Product and Byproduct Costing	61
<i>A. F. Dershawitz, H. R. McEntee</i>	

CORROSION REFRESHER

Consider Nonoxidative Corrosion	56
<i>Robert V. Jelinek</i>	

Engineering

Vol. 65, No. 26

Wallace F. Traendly Publisher
Sidney D. Kirkpatrick Editorial Director

CE COST FILE

- Floating Head and Fixed Tube Sheet Exchangers** 63
H. J. DeLamater

PLANT NOTEBOOK

- Water Still Controls Itself Automatically** 65
H. Leslie Bullock
Simplified Siphon Also Holds Its Prime 66
C. F. A. Roberts
Electronic Oven Defrosts Enzymatic Material 66
Norman L. Hobbs
Avoid Excess Dilution in Recovering Condensates 66
Jerome A. Seiner

YOU AND YOUR JOB

- A Medley of Salary Data for 1958** 67

CORROSION FORUM

- Lining Technique Halves Vessel Cost** 68
J. F. De Lorenzo

Other Regular Features

- Petrochemicals & Petroleum Refining Index** 5
Firms in the News 97
Convention Calendar 99
More New Equipment Developments 100
Technical Bookshelf 104
Classified Section 115
Equipment Searchlight 116

Reader Service

- Guide to Technical Literature** 108
Reader Service Postcard 105
Reprints Now Available 107
Advertisers in This Issue 120

Engineering Developments

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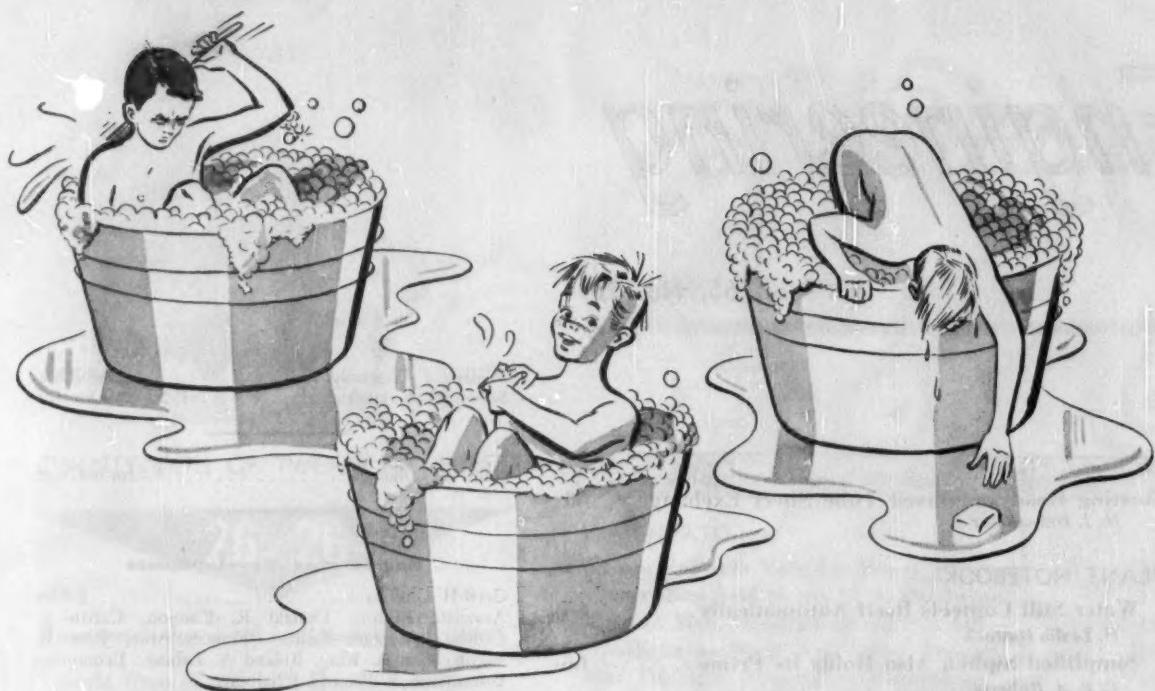
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CE is edited for the engineers who develop, design, build, operate, maintain and manage chemical operations of all types. More engineers subscribe to CE than to any other magazine in the field. Print order of this issue:

48,562



What do you do with the Wash Water?

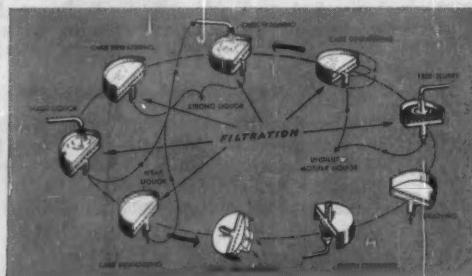
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Chemical Engineering

This issue's
top features in...

Petrochemicals & Petroleum Refining

DEC. 29, 1958

Also of Basic Interest

Clementator	17
Processes & Technology	
Information Retrieval ..	28
Chemical Economics	
Fertilizers	32
Chemical Products	36
Process Equipment	38
Process Flowsheet	42
Feature Articles	51
Corrosion Refresher	
Nonoxidative Corrosion	56
CE Cost File	
Sheet Exchangers	63
Plant Notebook	65
You & Your Job	
Salary Data	67
Corrosion Forum	
Lining Technique	70
Firms in the News.....	97
Calendar	99
More New Equipment....	100
Technical Bookshelf	104
Technical Literature	108

Combustion gas turbines are in the running 19

At Esso's Bayway refinery dual-shaft combustion gas turbines compete with conventional power sources, boast high over-all efficiency and fuel flexibility.

Intense arc pierces temperature barrier 24

Besides doing such esoteric jobs as fueling space craft, above-15,000-F. arc can spray-coat refractories onto surfaces and produce reactions once considered impossible.

High-pressure poly persists 42

. . . Polyethylene, that is. She's a reigning polymer who refuses to abdicate. Here's a view of her flowsheet at one high-pressure plant of recently doubled capacity.

Estimate costs of a solvent recovery system 51

Use these charts and figures to evaluate costs in building and operating an activated-carbon solvent recovery setup. You'll find basic costs and additional cost factors.

Find cost of joint products and byproducts 61

Meat packers have solved this problem to their own satisfaction. But now here's a system especially for chemical manufacturers, based on engineering know-how.

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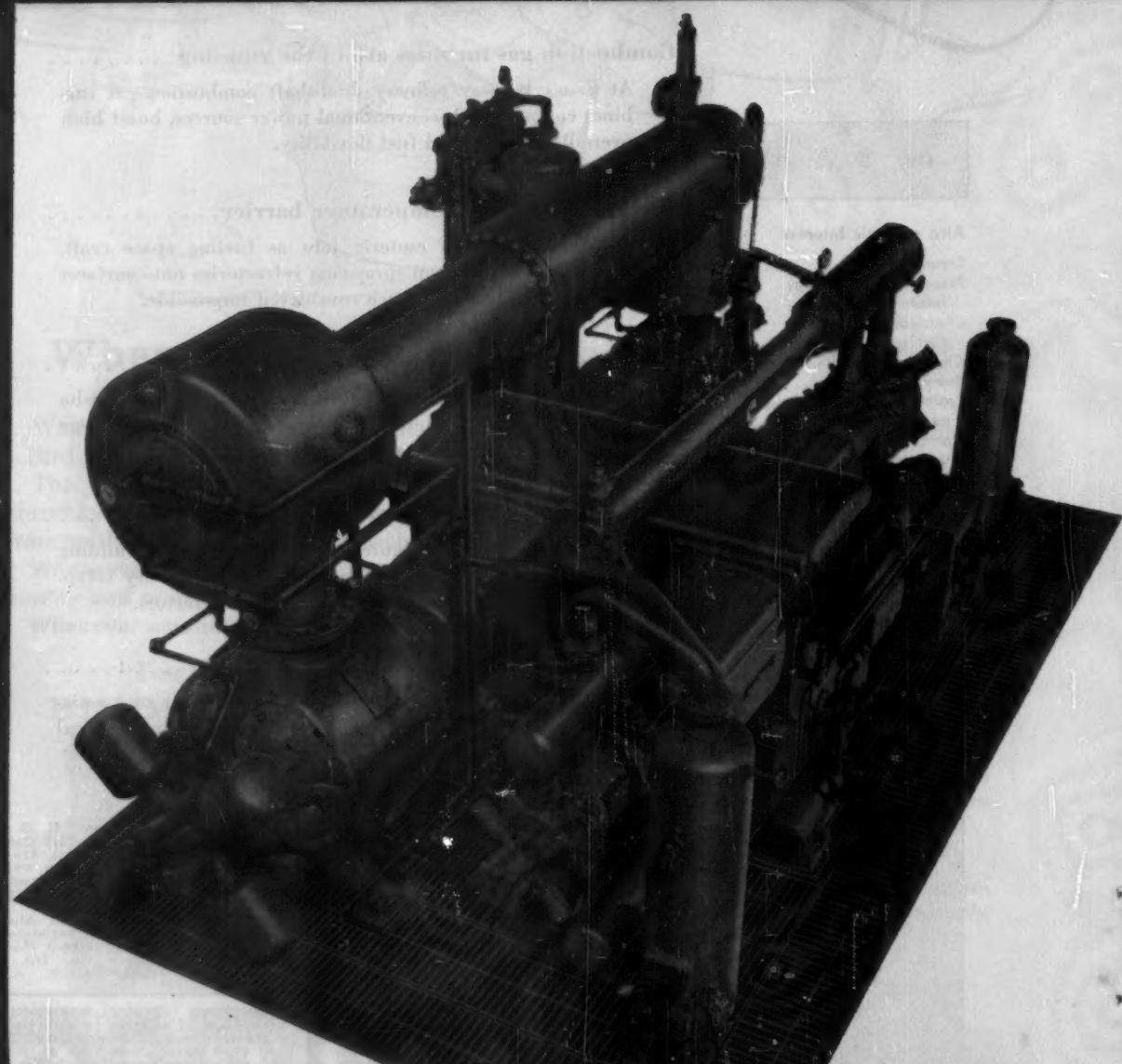
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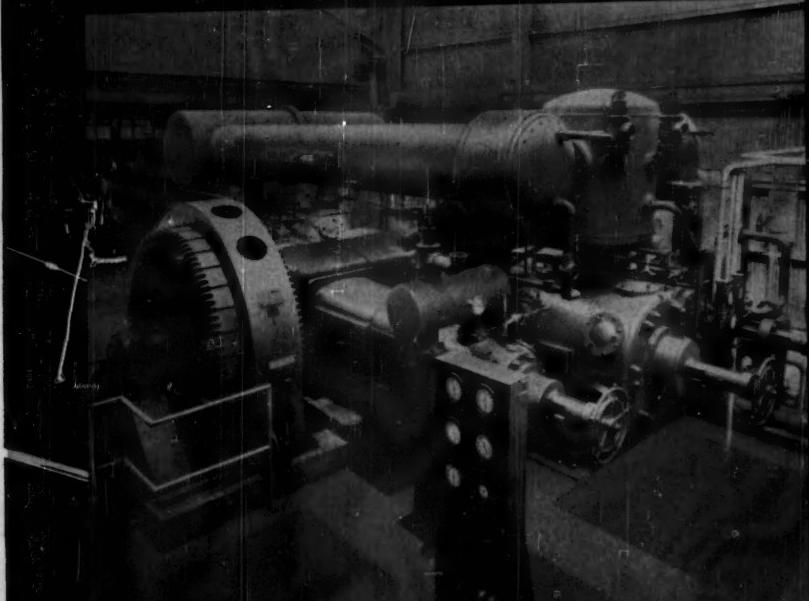
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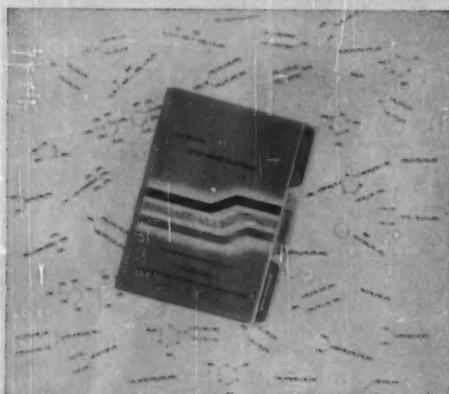
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Life on the Chemical Newsfront

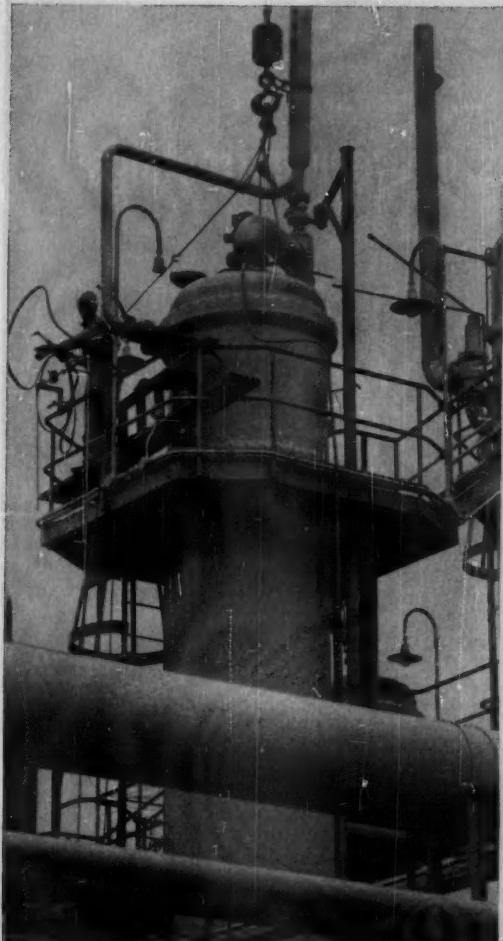


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(Lederle Laboratories Division)

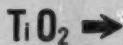


A NEW LINE ON NEW PRODUCTS is just off the press. A complete listing of new chemicals offered by Cyanamid's Market Development Department has been published. Researchers seeking new compounds for new applications or a fresh starting point for synthesis will be extremely interested in this revised, up-to-date edition. These products, from Cyanamid's research and development laboratories, are classified as "commercial," "limited" and "research" — an aid to those wanting answers now and those with an eye to the future. (Market Development Dept.)



A NEW EYE ON TEXTILE DYEING—the Microdyeoscope, an instrument with attachments for individual photographs as well as time lapse and motion picture photography, aids the study of the behavior of single fibers, microscopically, under conditions and cycles typical of commercial dyeing procedures. Designed to facilitate the study of the mechanism of dyeing, the Microdyeoscope has shed new light on dyeing processes. It has proved particularly valuable for the rapid evaluation of dyes and dyeing techniques, especially those for the new synthetic fibers. The inventor of this latest model Microdyeoscope, Mr. Henry E. Millson, a Cyanamid scientist, is shown operating the instrument. He recently received the Olney Award of the A.A.T.C.C. in recognition of a lifetime of valuable contributions to the field of dye application to textiles.

(Organic Chemicals Division)



OUTPUT DOUBLES AT TWO PLANTS to meet demand for two dissimilar chemicals. Titanium dioxide—so inert that its brilliant white opacity is unaffected by weathering or by most chemical environments—is now available in greater quantities from Cyanamid's recently expanded facilities at Savannah, Georgia. Acrylonitrile—a highly reactive monomer and intermediate—is the other. The additional output at Cyanamid's Fortier plant in Louisiana will meet the increasing demands for a broadening range of acrylonitrile-based plastics, rubbers and coating resins. In these same areas of application, titanium dioxide finds its major markets as a superior white pigment. (Pigments Div. and Organic Chemicals Div.)

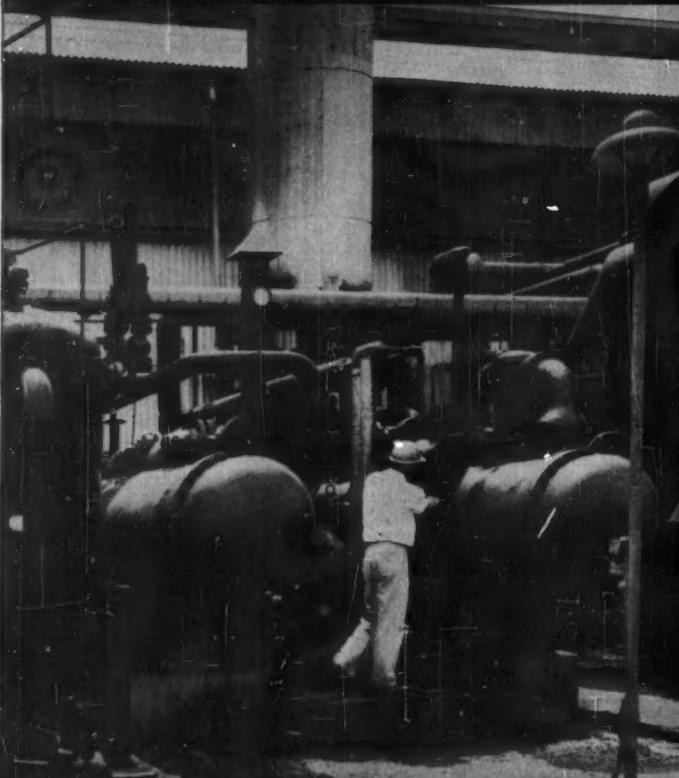


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For further information on these and other chemicals, call, write or wire American Cyanamid Company

At Spencer Chemical Company Ammonia Plant...
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per hour at 600 psi
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60° F dewpoint

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per day at 300 psi
and 40° F to minus
80° F dewpoint

At Spencer Chemical Company's Vicksburg, Mississippi plant, ammonia is produced by a process employing partial oxidation of natural gas. The other raw material is air... about 1,000 tons per day are liquified in an air-separation plant.

Lectrodryers stretch periods between defrosting... cut processing slowdowns and extend heat exchanger life. They DRY a million feet of saturated air per hour to a minus 60° F dewpoint... 20 million cubic feet of saturated hydrogen per day to a minus 80° F dewpoint.

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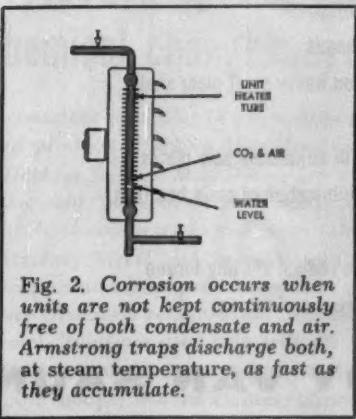


Why a Steam Trap Has to Handle "Air"

Low temperatures and corrosion of equipment
are often evidence of inadequate trap air venting capacity

Air, with its load of oxygen and carbon dioxide, has an unwholesome habit of interfering with the efficiency of steam heated units. If steam were always free of these undesirable companions, things would be a lot simpler for men-who-operate-plants. Because it isn't, three unhappy situations frequently occur:

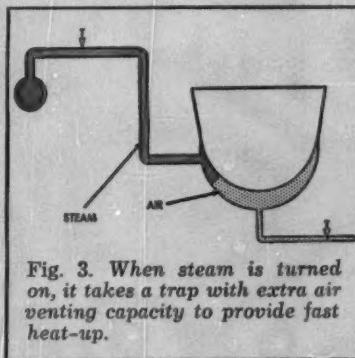
1. Operating temperatures are subnormal. This is a two-part problem. First, an air-steam mixture has a lower temperature than pure steam at the same pressure—see Table A. Secondly, air can "plate out" on heat transfer surfaces as shown in Figure 1. Under some conditions, such an air film will knock down heat transfer efficiency by as much as 50%.



2. Corrosion rears its ugly head. Oxygen and carbon dioxide are real trouble-makers. CO₂ gas goes into solution in condensate, forms carbonic acid and chews away at vulnerable metal sections. O₂ aggravates the situation. See Figure 2.

TABLE A—How air reduces steam temperature.

Gauge Pressure	Temp. of Steam with No Air Present	Temp. of Steam Mixed With Various Amounts of Air (% Air by Volume)	
		10%	30%
10.3	240.1	234.3	220.9
25.3	267.3	261.0	246.4
50.3	298.0	291.0	275.1
75.3	320.3	312.9	295.9
100.3	338.1	330.3	312.4



3. Heat-up is slow as a snail. Air has a picnic in units that are shut off periodically. Figure 3 pictures the problem. Lines and equipment literally fill up with air. When the steam is turned on it can get in only as fast as the air gets out.

Enter Steam Traps

Curing these steam system ailments involves an operation sometimes called a "trap transplant." It consists of removing traps that don't get the air out and replacing them with traps that do.

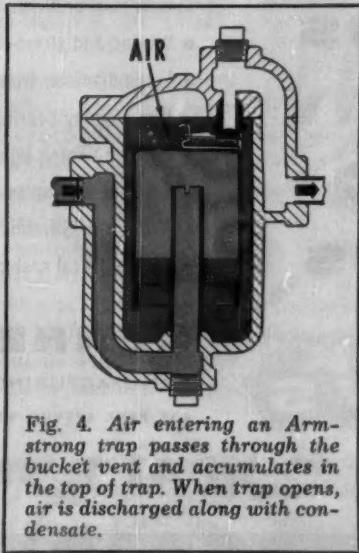
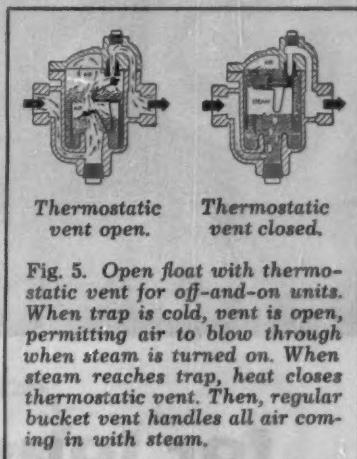


Figure 4 shows how an Armstrong inverted bucket trap continuously vents air. What the picture doesn't show is a built-in plus-value of this trap's design. An Armstrong trap opens suddenly, creating a momentary pressure drop and turbulence in the unit being drained. This breaks up air films and "pumps" air down to the trap so it can be vented.

The vents in standard Armstrong trap buckets will pass all the air normally encountered. In special cases, such as paper machine dryers, the vents are correctly sized larger at the factory to meet the requirement.



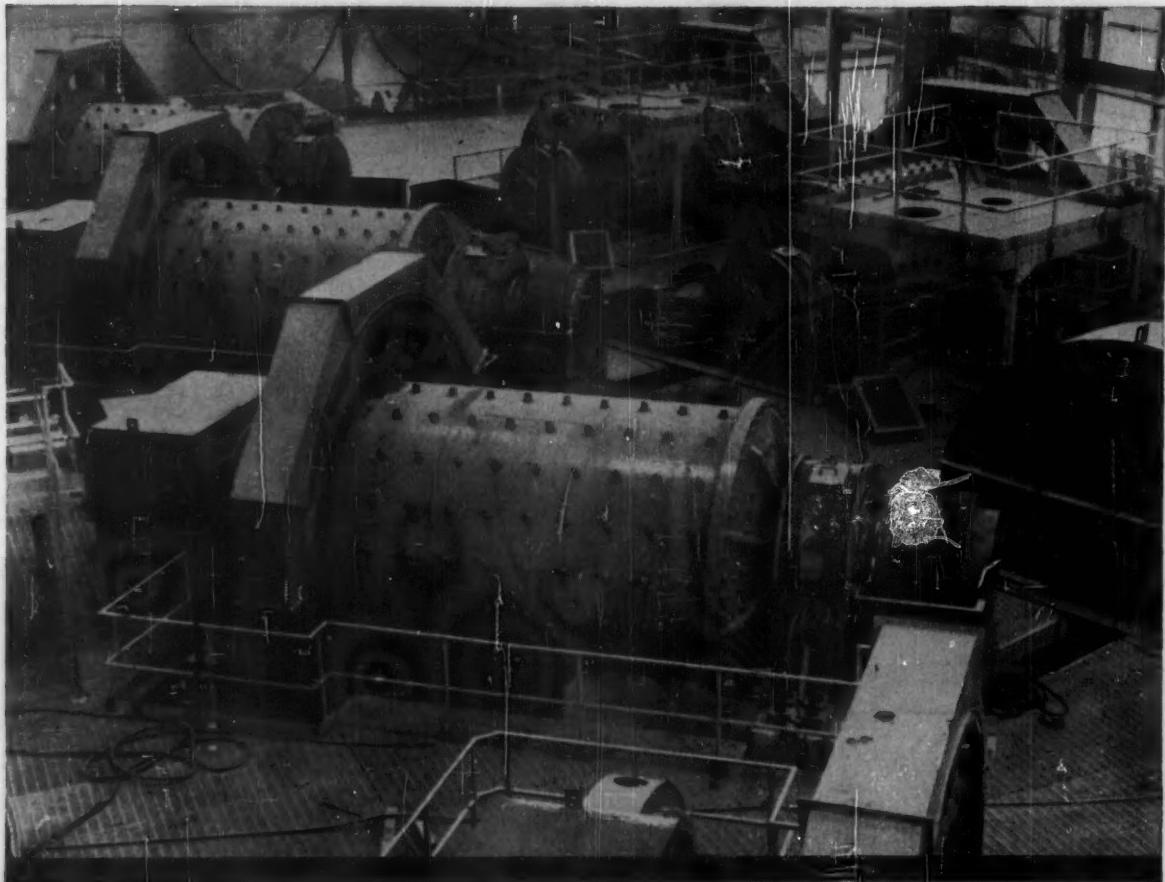
Open Float with Thermostatic Vent

Super air-venting capacity is a must for fast heat-up of low pressure unit heaters, heating coils, steam headers and other units that are on-and-off. Figure 5 shows how the Armstrong open-float-with-thermostatic-vent trap takes care of this.

The 44-page Armstrong steam trap book covers other features of the Armstrong trap as well as its excellent air handling characteristics. This catalog also discusses trap selection, installation and maintenance. Your local Armstrong Representative or Distributor will be glad to give you a copy. Call him, or write Armstrong Machine Works, 8587 Maple Street, Three Rivers, Michigan.



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STEAM TRAPS



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grinding
problems**

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Rod Mills



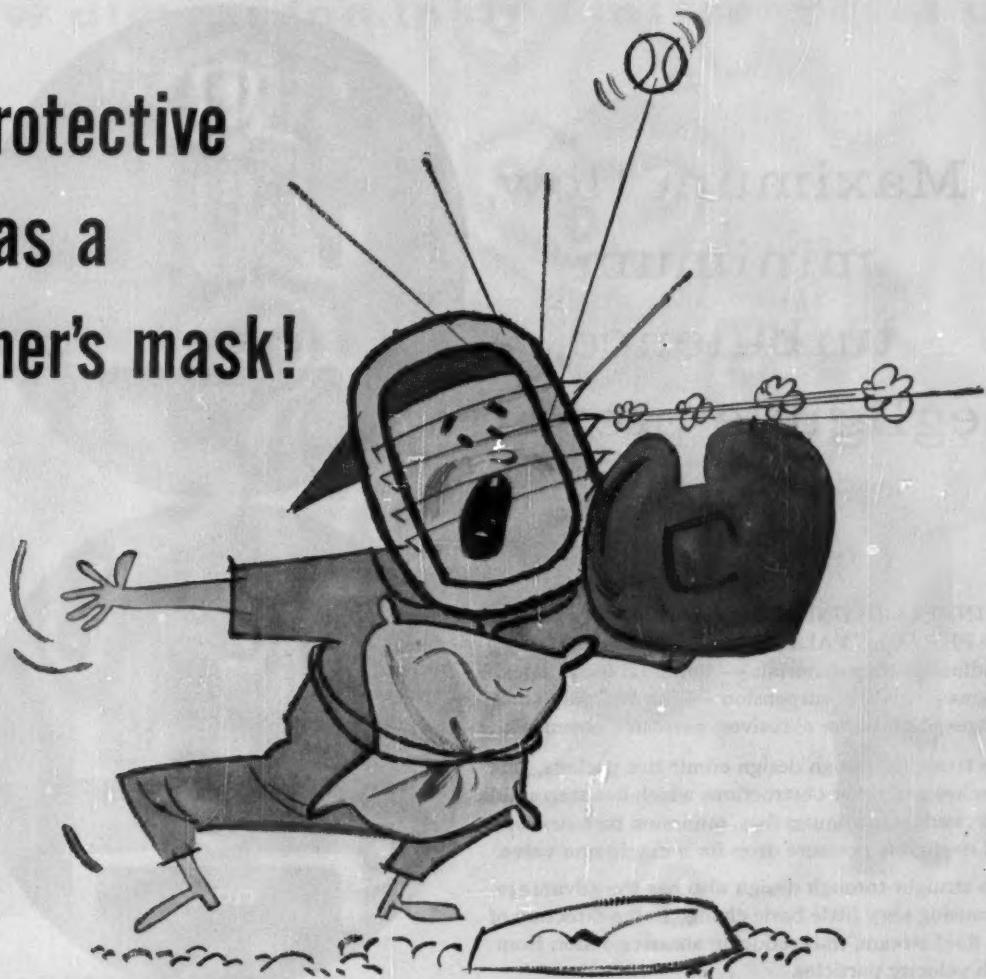
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- Oil-tight bearing seals
- Motorized hydraulic lift to reduce starting torque
- Single helical cast steel gear and pinion

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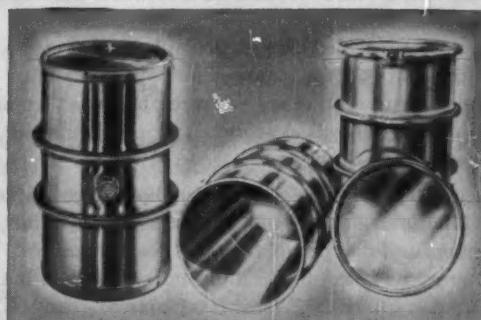
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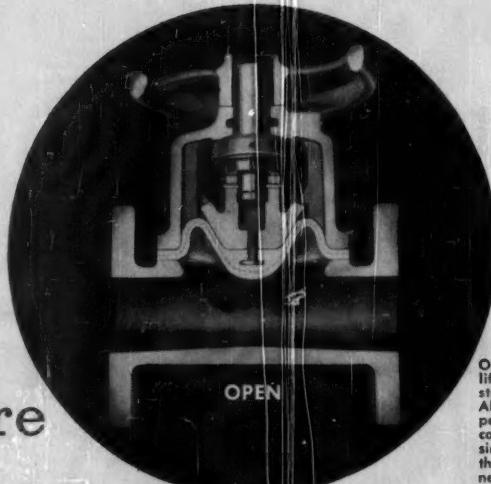
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The straight-through design also has the advantage of causing very little basic change in the direction of the fluid stream, thus reducing abrasive action from high velocity particles.

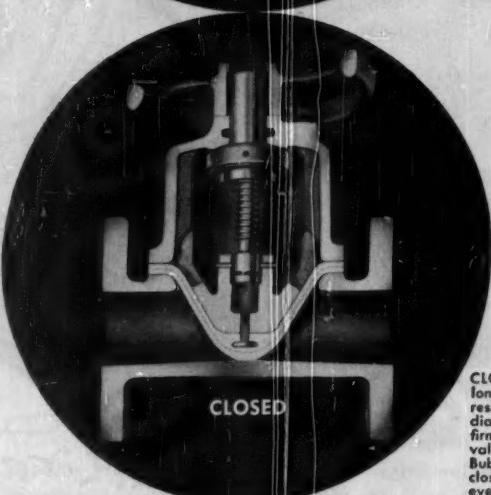
These advantages are in addition, of course, to benefits normally associated with the use of diaphragm valves . . . such as freedom from corrosion and clogging of working parts, since these are completely sealed off by the diaphragm; prevention of product contamination; elimination of stem leakage and routine maintenance, because there are no packing glands. Also, when properly pitched, lines are self-draining.

Grinnell-Saunders Straightway Diaphragm Valves are available in a choice of body sizes and materials, linings and diaphragms. Handwheel or power operated. For complete information, write Grinnell Company, Inc., 277 West Exchange St., Prov. 1, R. I.

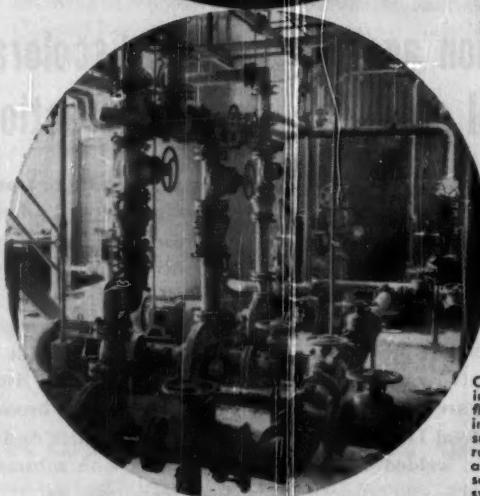
*Patented



OPEN Diaphragm lifts high for streamline flow. Also, valve design permits comparatively simple rodding through, when necessary.



CLOSED Despite long usage, resilient diaphragm seals firmly against valve body. Bubble-tight closure is assured, even when handling gritty or fibrous materials.



Clogging and interruption to flow is prevented in lines handling a suspension of rubber particles in an acid brine solution at this synthetic rubber plant.

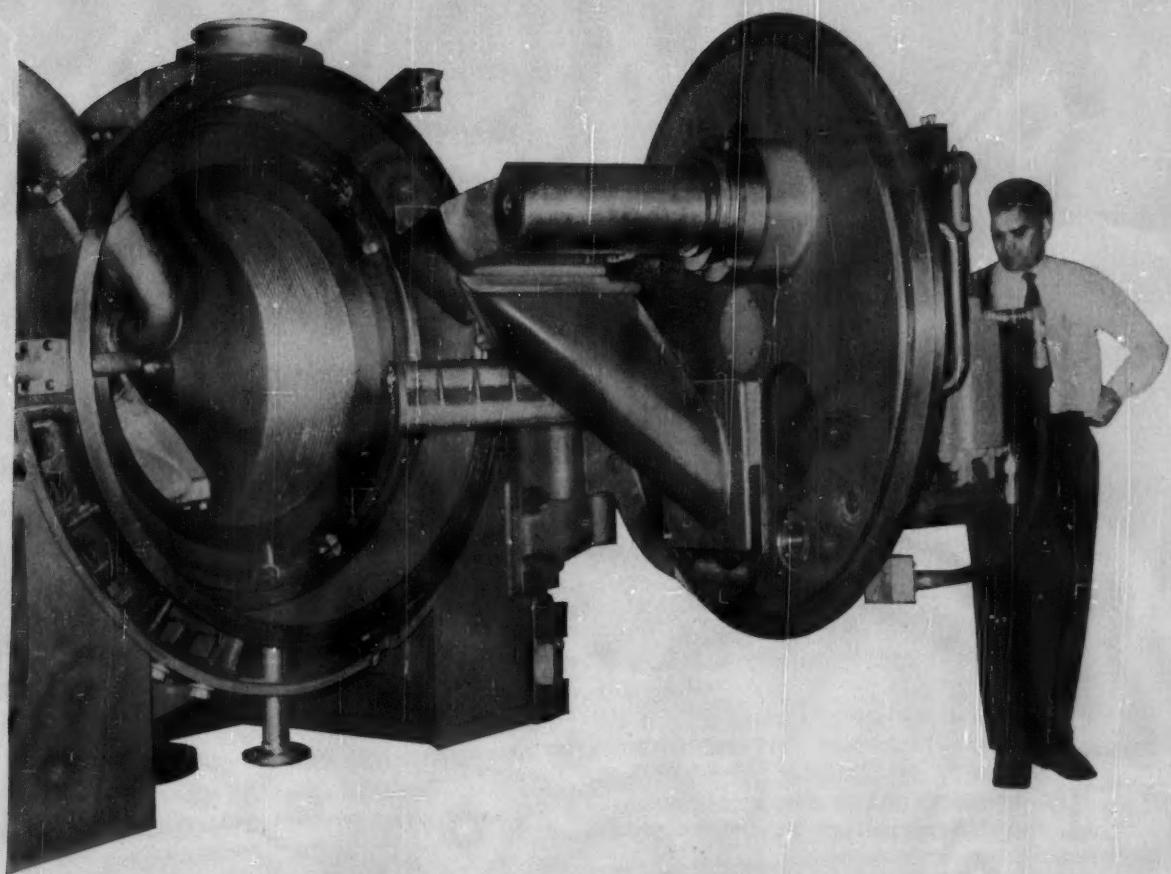
GRINNELL-SAUNDERS DIAPHRAGM VALVES

Grinnell Company, Inc., Providence, Rhode Island

Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

a new dimension in crystal dehydration



**CAPACITIES OF
THE NEW SHARPLES C-41 SUPER-D-HYDRATOR ON
REPRESENTATIVE SLURRIES.**

AMMONIUM SULFATE—a relatively large free-draining inorganic crystal . . .

20-24 tons/hour

"CAUSTIC SALT"—a relatively small, slower draining crystal requiring high efficiency rinsing . . .

13-16 tons/hour

POLYPROPYLENE—typical of extremely fine, slow draining, low bulk density organic solids . . .

1.0-2.5 tons/hour

The C-41 Super-D-Hydrator is the largest of 3 high efficiency crystal drying centrifuges by Sharples (C-20,C-27;C-41) which are designed for both atmospheric and pressurized operation, and are available in various standard materials of construction.

Sharples engineers have incorporated many innovations in the design of the new C-41, learned in over 40 years experience in the chemical industry, and are further prepared to give special design consideration to each specific problem. May we consult with you regarding your separation problems?

SHARPLES

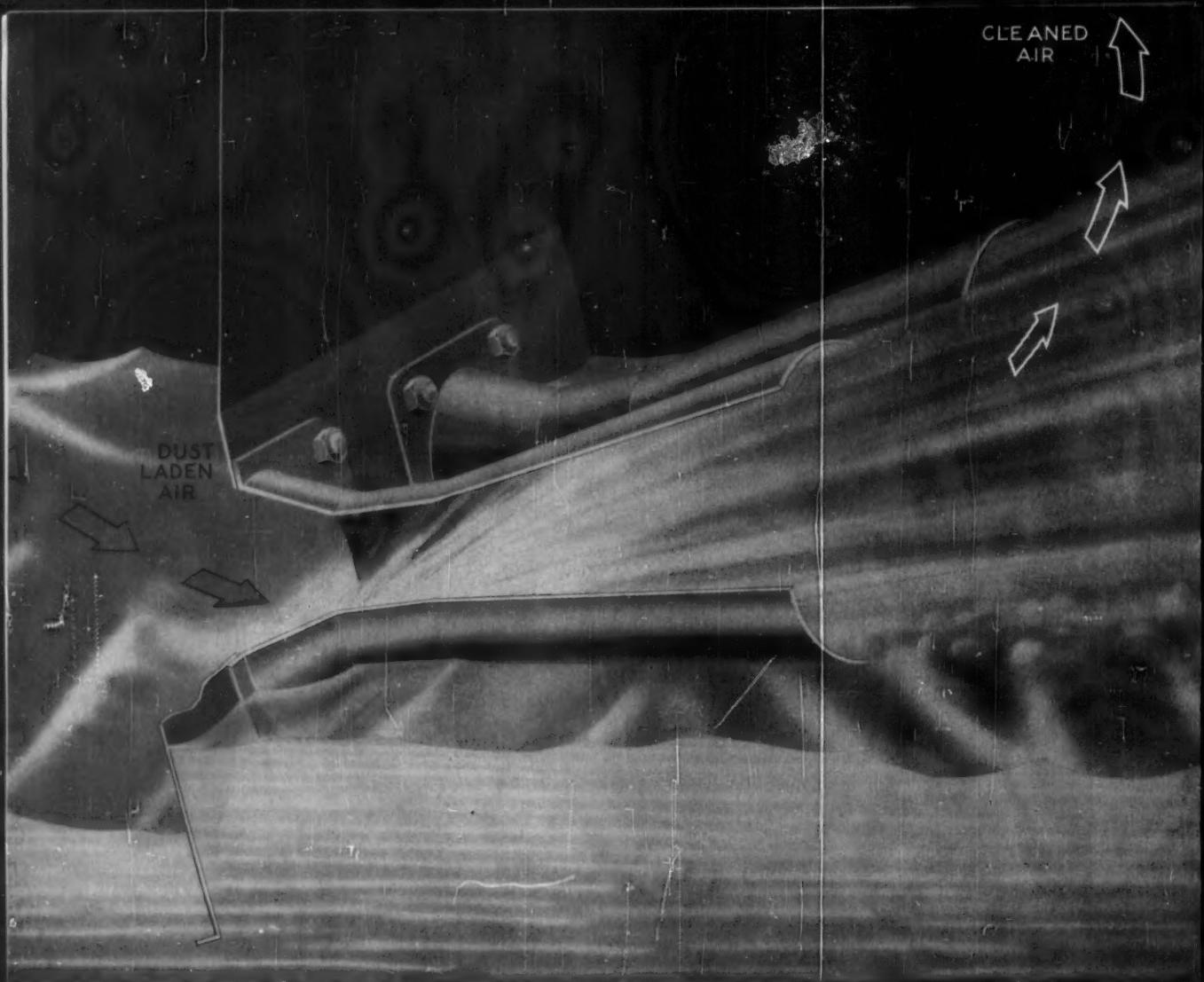
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Puts the squeeze on difficult dusts

**Pangborn Ventrijet Wet Dust Collector uses
exclusive venturi tubes for peak efficiency**

Pangborn Ventrijet Wet Dust Collector on the job. This is just one of Pangborn's comprehensive line of wet and dry dust collectors.

That pinch-necked venturi tube is the secret behind Pangborn Ventrijet performance. As dust-laden air flows through these tubes, the constriction creates a low-pressure area which draws water into the air stream. The resulting turbulence breaks the water into particles which actually wash the dust from the air. The simplicity of Ventrijet design saves money in its ease of installation, its low cost of operation and maintenance.

Although the Ventrijet is particularly suited to collecting hot, moist, inflammable, corrosive and obnoxious dusts, the Pangborn engineering it typifies is important to any dust-producing

plant. It is not enough to put a dust collector within a plant. An efficient dust control system must be scientifically planned, designed and constructed to handle effectively a specific dust problem. This thinking is incorporated into every Pangborn proposal.

The Pangborn Engineer in your area will be glad to go to work for you. He is a dust expert and will discuss your individual problem at no obligation. And, for more information, write for Bulletin 922 to: Pangborn Corp., 2600 Pangborn Blvd., Hagerstown, Md. Manufacturers of Dust Control and Blast Cleaning Equipment.



Pangborn
CONTROLS DUST



DEVELOPMENTS ...

DECEMBER 29, 1958

Chementator

C. H. CHILTON

Electrolytic refining of titanium reached advanced pilot-plant stage this month when Bureau of Mines, Boulder City, Nev., put on line a new 10,000-amp. cell with capacity of 400 lb./day. Feed will be unalloyed scrap and off-grade sponge.

Pocatello court has thrown out Central Farmers' counterclaim charging Monsanto with attempts to monopolize the field of elemental phosphorus manufacture (*Chementator*, Oct. 6, p. 48). Court says CFF's argument wasn't "technically appropriate."

New salary requirements for exemption from overtime pay go into effect on Feb. 2. Administrative and professional employees must be paid at least \$95/week to be so exempt, vs. \$75 now required. Special exemptions for shortened duty will require \$125/week minimum vs. \$100 now.

Three refiners vote for Penex process

Isomerization of straight-chain C₅-C₇ paraffins—long touted as the next major process route to higher octanes—now has three backers:

- Phillips reports successful operation of its 34,000-bbl./day pentane unit at Borger, Tex. (*Chem. Eng.*, Dec. 1, p. 60).
- Atlas Processing Co. last month started up a new unit at Shreveport, La., to isomerize 3,800 bbl./day of hexane.
- Gulf Oil has started building a unit at Port Arthur, Tex., for isomerizing 10,000 bbl./day of pentane.

Although a number of various isomerization processes have been developed to the point of being offered for licensing, only Universal Oil Products' Penex process has so far made the grade commercially. Phillips and Atlas are both using Penex. And while Gulf calls it process "hydroisomerization" to distinguish it from Penex, the company gives UOP partial credit in its development.

Gulf, incidentally, says that it will be first to use platinum catalyst for isomerizing pentanes, indicating that Phillips' pentane operation is probably using some other catalyst of Phillips' own choosing.

Superphos acid to get U. S. producer

Superphosphoric acid, pioneered by Tennessee Valley Authority chemical engineers, will soon go commercial in the U.S.

Central Farmers Fertilizer Co. now plans to convert elemental phosphorus from its new 35,000-kw. electric furnace plant at Georgetown, Idaho, into super acid. Canada's Electric Reduction Co. began similar operations earlier this year. TVA has also been supplying demonstration quantities to the fertilizer industry (*Chementator*, Oct. 1957, p. 137).

More concentrated (76% P₂O₅) than ordinary furnace acid (around 54% P₂O₅), superphosphoric acid can be produced at a cost not significantly greater per unit of P₂O₅. In gen-



new safety in hazardous areas *indoors or out!*

Hurricane protection

direct streams of water

dousing washing down

explosives to

break into safer

or these new safe

explosion-proof

control stations

NEW THREADED-JOINT NEOPRENE-SEALED Control and Indicating Stations

Explosion-proof, dust-ignition-proof, weather resistant and water-tight (NEMA 4), this new Condulet® EWC series affords safety greater than ever before for pilot lights, heavy-duty push-button stations, selector

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literature and specifications, or
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switches, or various combinations thereof in single, double or triple gangs.

Designed expressly for Class I (Groups C and D) and Class II hazardous areas, the new series features a Feraloy® housing with *threaded* cover and *threaded* operating-shafts throughout. Cover, shaft housing and pilot light jewels are tightly sealed with Neoprene O-rings, effectively shutting out fumes, dusts, all water.

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MAIN OFFICE AND FACTORY: SYRACUSE, NEW YORK

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• TRAFFIC CONTROL SYSTEMS • AIRPORT LIGHTING and WEATHER MEASURING EQUIPMENT •

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eral, the same kind of plant is used. And lower operating temperature (155 vs. 212 F.) decreases corrosion of equipment.

Super acid offers a big potential advantage in lower shipping costs. Phosphoric acid above 58% has previously been classified as "food-grade," which ships at rates about twice as high as low "fertilizer-grade" concentrations. TVA has been fighting to get super acid carried at fertilizer acid rates. This fight has been only partially successful; Southern railroads decided in September that super acid should get a lower rate than food-grade, but higher than fertilizer-grade in direct proportion to its P_2O_5 content.

Freight cost is highly important to Central Farmers, whose outlets are in the Midwest. CFF first planned (*Clementator*, May 1957, p. 144) to convert its furnace phosphorus into calcium metaphosphate (a high- P_2O_5 -content solid) to save on shipping costs, then process cal meta into high-analysis mixed fertilizers in the Midwest. Technical difficulties are holding up this program.

Instead, CFF will convert its phosphorus into high-analysis superphosphates via the super acid route, begging the question—for the time being, at least—of freight rates.

How to make modernization pay off

Operating employees at Anaconda's electrolytic zinc plant—first refusing to go along with company plans to boost productivity—quickly changed their tune when the company announced that production would be transferred to another plant.

In order to put its zinc operations at Anaconda, Mont., on a more competitive basis, the company recently installed labor-saving air hoists in the tank house and asked the operators to strip 18 tanks of cathodes per shift instead of 12. The union (Mine, Mill and Smelter Workers) refused. Anaconda then announced that zinc operations would be transferred to its Great Falls plant, where production costs are much lower. Some 250 employees would have been affected.

Two days later the union voted 35-20 to strip 15 tanks per shift for a 30-day break-in period, then increase output to 18 tanks. Anaconda immediately reversed its earlier decision to shut down the plant.

Meanwhile, in Alcoa, Tenn., Aluminum Co. of America is negotiating with United Steelworkers over similar problems. Productivity

at the Tennessee plant is lower than at the company's newer smelting plants. However, the older plant has carried out a constant program of modernization which, the company feels, justifies improved productivity.

The union disagrees and has threatened to strike. Although admitting the possibility of moving operations elsewhere, the company expects to reach an amicable settlement.

Gas turbines score economic coup

The combustion gas turbine as a prime mover is now competing with steam turbines and electric motors at Esso Standard's Bayway (N. J.) refinery.

Esso operates three dual-shaft, 9,000-hp., Clark Bros. gas turbines, all driving centrifugal compressors. Two are on an ethylene unit, burning 600-Btu./cu.-ft. process tail gas. Another, on a Powerformer unit, uses 500-Btu. process tail gas. The turbines, however, can handle any gas of 500-2,500 Btu./cu. ft. heating value or can even be modified to use liquid fuels.

Large-scale process uses of gas turbines to date (e.g., Houdry fixed-bed catalytic cracking, nitric acid manufacture) have taken advantage of the availability of hot combustion products from the process. Such gases have little or no fuel value; their recoverable energy content is due to their sensible heat and pressure level.

Esso sends the hot (875 F.) turbine exhaust gases to coolers, where they generate steam for the refinery grid. This boosts overall thermal efficiency from a nominal 18% to about 75% and helps swing the economic balance toward the combustion gas turbine as a prime mover.

Spotlight on soda ash from trona

Word that Diamond Alkali is exploring trona beds in Wyoming's Green River Basin suggests that this low-cost source of soda ash, despite its distance from large markets, offers the alkali industry an attractive alternative to major expansion of the ammonia-soda process.

Food Machinery & Chemical has been producing soda ash from Wyoming trona since 1953. Initial capacity of 1,000 tons/day will be boosted 20% when additional facilities now

(Continued on page 22)

ENTIRELY NEW PRINCIPLE enables you to...

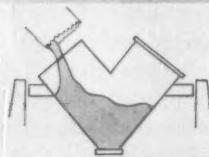
Blend

liquids and solids
intimately in one operation

It is now practical, with the P-K "Twin-Shell"** blender, to blend many difficult formulations that have heretofore been either impossible or impractical because of the number of separate operations required to achieve a desired product. With the new "Twin-Shell" blender,

liquids, solids, clumpy and crystalline materials can all be intimately blended in one operation. Average blending time: 5 to 15 minutes. The P-K "Twin-Shell" blender is unlike any other blender. It works on an entirely new blending principle. Here, in diagram, is how it works.

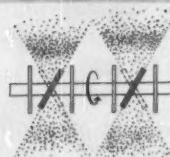
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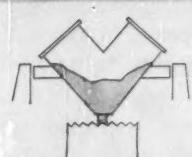
CHARGE DRY SOLIDS through top of either shell. Optimum charge level for most materials is about 65% of total shell volume.



TUMBLE AND AERATE. As shell revolves, rapidly spinning wire cage intensifier breaks up agglomerates, literally creates dust storm in material.



ADD LIQUID. Centrifugal force sprays atomized liquids from periphery of control discs on Liquid-Feed Bar into finely dispersed solids.



DISCHARGE PRODUCT easily through apex of shells. Accessibility of interior and easy removal of Liquid-Feed Bar speed cleaning.

Get new ideas for your
blending process at P-K's
pre-test lab



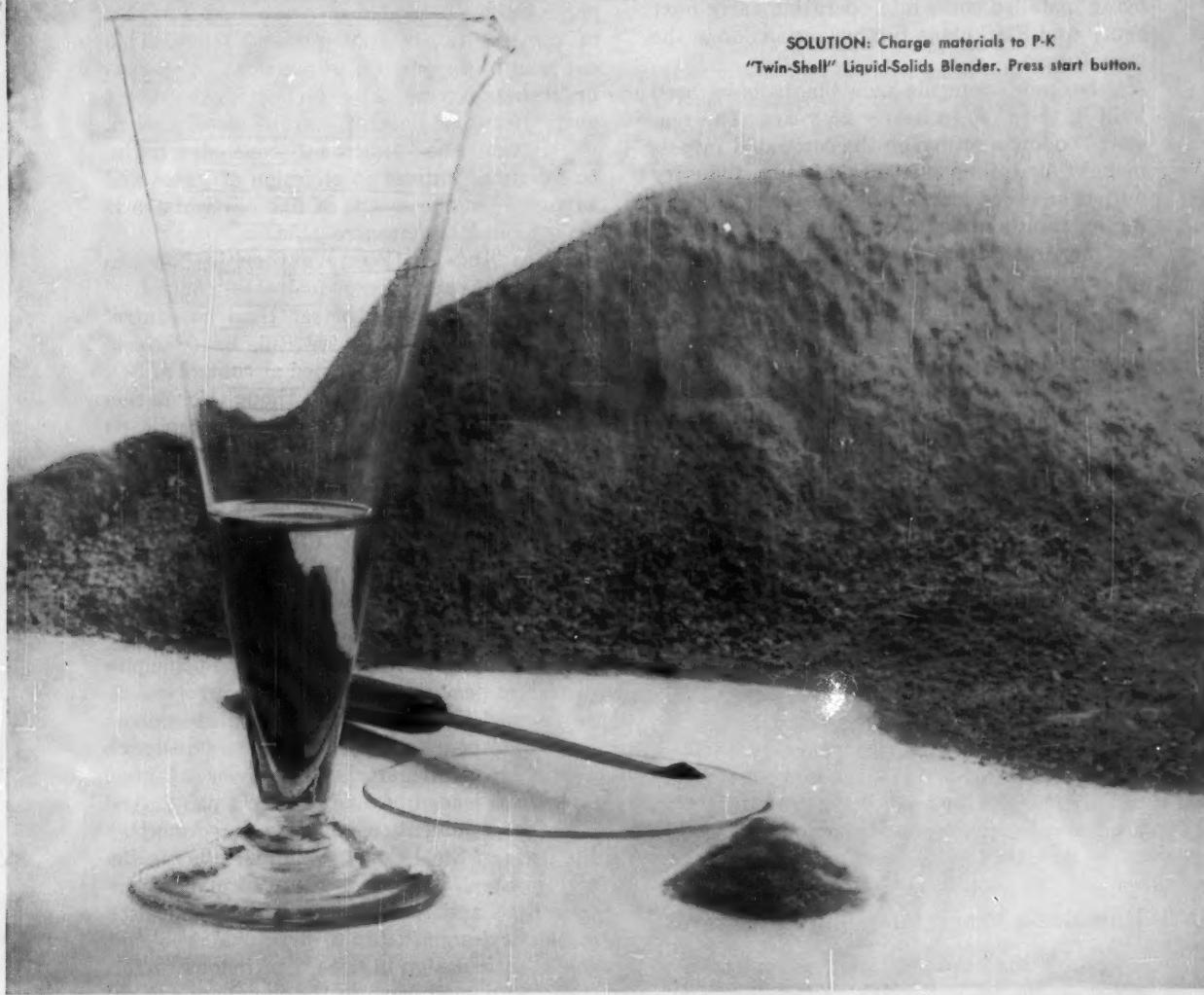
Complete, scientific investigation of all types of blenders now available at Patterson-Kelley.

Blending of complex formulations is full of variables. The equipment and procedure that are ideal for one combination of ingredients may be unsatisfactory for another. Proper selection of equipment demands thorough scientific investigation. You can conduct your investigation at Patterson-Kelley's Customer Pre-Test Lab, at East Stroudsburg, Pennsylvania. Since P-K makes practically all types of blenders, you can run conclusive comparison tests with your materials. Trained technicians will help you.

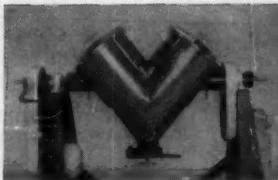
To set up an appointment, just place a collect call to Russell Dotter at Patterson-Kelley. Tel. No.: Stroudsburg 820. He'll be happy to tell you how much of your materials to bring and to give you other details. East Stroudsburg, in the Pocono Mountains, is just 2 hours from New York City, easily accessible by all carriers.

PROBLEM: to blend—precisely—varying amounts of lumpy solids, powders, crystalline materials and small amounts of liquid.

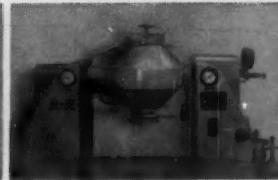
SOLUTION: Charge materials to P-K "Twin-Shell" Liquid-Solids Blender. Press start button.



"TWIN-SHELL" Liquid-Solids laboratory models are made in transparent Lucite or stainless steel, in 8 and 16 quart sizes.



PRODUCTION MODELS of the "Twin-Shell" blender range up to 50 cu. ft. capacity. (Intensifier and Liquid-Feed Bar optional.)



VACUUM TUMBLE DRYERS by Patterson-Kelley are available in sizes down to the standard 1 cu. ft. capacity lab model.



PRODUCTION MODELS of the Vacuum Tumble Drier have capacities up to 150 cu. ft., come factory aligned, piped, instrumented.

BLENDER LITERATURE. Specialized information and data in greater detail are given in two Patterson-Kelley publications: Bulletin No. 16, Chemical Process Equipment and Bulletin No. 15A-1, Twin-Shell Laboratory Blenders. Write for your copies today. Patterson-Kelley Company, Chemical and Process Equipment Division, 1512 Hanson St., East Stroudsburg, Pa. 15



Patterson Kelley

Chemical and Process Equipment Division

being installed come into operation early next year, And FMC plans further expansion in the near future.

No new ammonia-soda plants have been built in the U.S. in nearly 25 years. The reason: Too low a return on the estimated investment of more than \$30,000/daily ton. Industry output has been increased, instead, by expanding existing ammonia-soda plants, by recovering more ash from Searles Lake brines and by carbonation of surplus caustic soda.

FMC's answer: Mining of solid trona (sodium sesquicarbonate) 1,500 ft. underground, hauling it to the surface, processing it to soda ash (*Chem. Eng.*, May 1953, pp. 118-120). Capital investment in mine and surface plant together is only about half that of an ammonia-soda plant. Operating costs are less, too.

Offsetting these advantages to some extent are freight costs. Also deterring prospective trona miners are the twin problems of getting options and proving out deposits.

But the balance would swing even more towards trona if fluid mining methods (similar to salt-brine wells) could be perfected. Don't be surprised if FMC comes up with such a development shortly. Two years ago (*Chem. Eng.*, Dec. 1956, p. 118) the company began testing the idea in a big way, predicting that process refinements would soon make the technique feasible.

How dusts synergize pollution hazards

Problems in air-pollution control take on a new dimension in the light of recent evidence that some gaseous pollutants are dangerous to the body only when associated with finely divided solids.

As D. A. Irwin, Alcoa's medical director, pointed out to the Manufacturing Chemists' Association last month, "An industry contributing only inert, nontoxic fine-micron particulate matter to the air may be just as responsible for adverse health effects as the industry contributing small amounts of a toxic gas, although singly these materials would cause no adverse effects."

Irwin explains that water-soluble gases and vapors in the air do not ordinarily reach the lungs; they are scrubbed out in the upper respiratory tract. On the other hand, many air-borne solid particles under 5 microns do reach the lungs. Gas or vapor can be adsorbed on the solid particles and liberated when the

particles are deposited on the moist surfaces of the respiratory passages and lungs. This can lead to serious bodily reactions—impaired breathing, extra load on the heart, even direct entry of a toxic irritant into the blood stream.

It would be "ludicrous," concludes Irwin, to set rigid controls on emission of gases and vapors when the escape of fine particulates is uncontrolled or uncontrollable.

Los Angeles County authorities, on the other hand, apparently feel that control of gaseous pollutants is better than no control at all. Its recently adopted Rule 62 (*Chementator*, Dec. 15, p. 65) is aimed at control of SO₂ emission from stacks, even though formation of dreaded acid smog admittedly depends on coexistence in the atmosphere of submicron particles of nucleating materials.

Cheaper structures via plastic design

Lower-cost steel structures, designed in less time and using 15-20% less material than conventional structures, will be possible through better understanding of the principles of plastic design.

American Iron & Steel Institute members last month heard a report on 12 years' research at Lehigh University on behavior of steel structures loaded beyond the yield point. And due for imminent publication by American Institute of Steel Construction is "Plastic Design in Steel," first of a group of manuals intended to assist engineers in the application of plastic design theory to structural problems.

Plastic design utilizes "continuous" structures, so named because the members are not free at the supports but are joined, as by welding, into a continuous unit. In such a structure every member contributes to the strength of the whole. Thus a single member may be stressed beyond its yield point but, instead of failure of the member as in a discontinuous structure, the stressed member draws on the reserve strength of the other structural members. In other words, criterion of plastic design is the ultimate load the structure will carry, as distinct from the point of first yield.

Although plastic design is not new, having been applied widely in Europe, American designers have shied away from the rigorous, complex design calculations involved. However, the work at Lehigh has now come up with simplified concepts which make plastic design faster than conventional elastic design and no less accurate.



RICHARD W. BROWN, Manufacturing Vice President,
Seidlitz Paint and Varnish Co., Kansas City, Mo.:
"We're from Missouri—and the Cowles showed us":



Pre-mix with

Dissolver multiplied mill input speed 800%

From a former average of 125 gallons to a new volume of 1000 gallons per man-hour! That's the mill input gain made possible by addition of a Cowles Dissolver pre-mix system. Comparable results can be yours through Cowles-engineered equipment and methods. Cowles' faster, more thorough preparation of your batches can multiply the speed of your entire operation—can increase workers' efficiency. It can greatly increase the output of your other equipment, or save valuable time when used as a reactor.

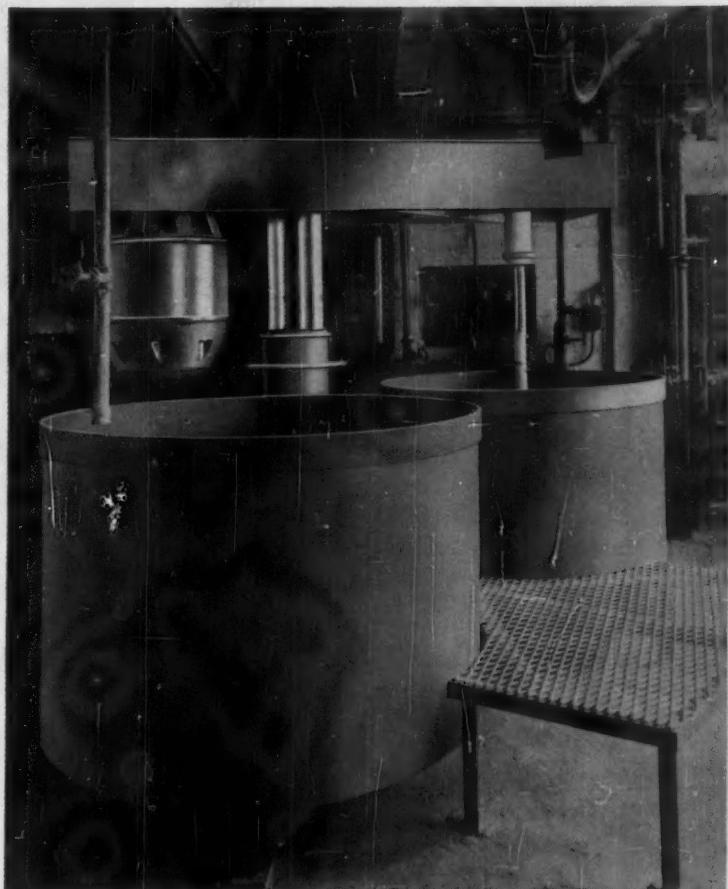
2½ times the mixing volume—in less space—at less cost

Expect these results in ultimate dispersion, dissolving, emulsifying and deagglomerating—in all processes involving solid-liquid, liquid-liquid and gas-liquid formulas. It's the teeth of the patented Cowles Impeller that give you this spectacular efficiency. And scientifically engineered power and drive systems insure complete control of the impeller action to give you the exclusive Cowles "MULTI-PHASE" mixing action. Cowles engineers will be happy to work with you in adapting the Cowles to your materials, processes and present equipment—and in solving your processing problems economically.

Let us prove it in your plant—at our risk!

It will pay you to take advantage of Cowles free trial installation plan.

Write today for complete information and catalog.



A Cowles Dissolver at work in one of two 500 gal. tanks used for pre-mix prior to milling at Seidlitz plant. When batch is finished, Cowles will swing to second tank.

5808



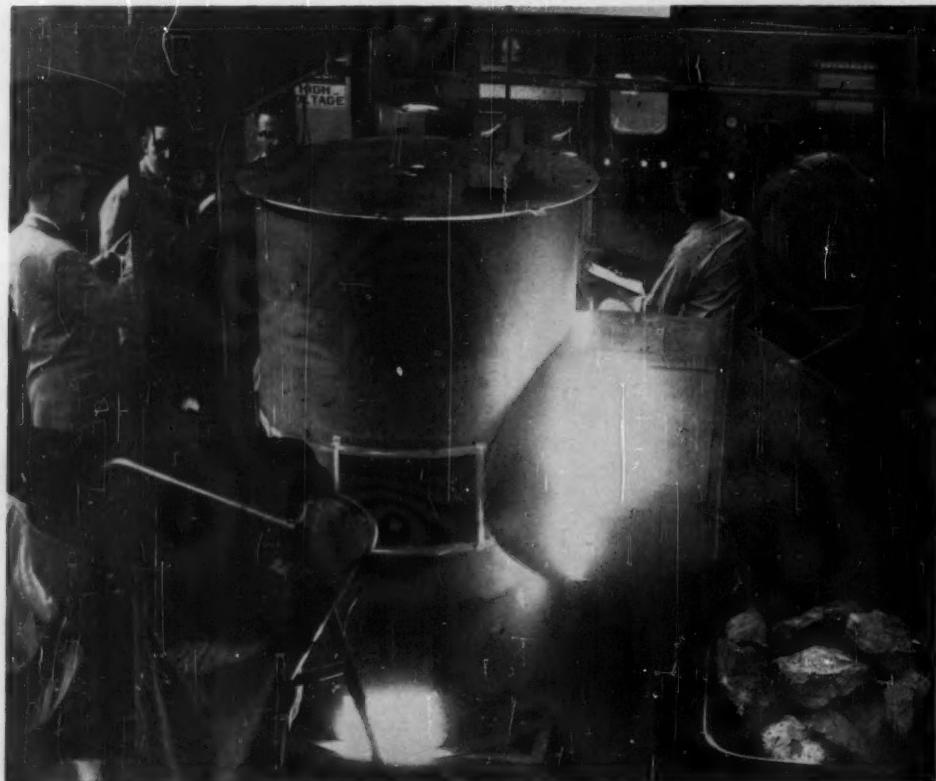
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DEVELOPMENTS...

PROCESSES & TECHNOLOGY C. S. CRONAN



INTENSE 13,000-18,000-F. heat from arc radiates from Vitro's manganese-process chamber.

Intense Arc Pierces Temperature Barrier

Producing temperatures at the 15,000-30,000-F. level, the high-intensity electric arc opens a completely new environment that engineers are now exploiting.

Raise your sights when you think of high process temperatures. Once limited by available heat sources to temperatures below 10,000 F., engineers now process materials at the 15,000-30,000-F. level attained with high-intensity electric arcs.

Four major developments now use this type of arc to provide high-temperature levels. Using this tool, engineers:

- Decompose or combine at ultra-high temperatures ma-

terials whose molecules are unreactive below 10,000 F.

- Spray-coat surfaces with refractory materials such as tungsten (m.p. 6,430 F.), columbium (m.p. 4,642 F.) and molybdenum (m.p. 4,748 F.). And spray-fabricate these same refractories into shapes needed for space-travel components.

- Fuel space vehicles with metals to be ionized and magnetically thrust from a space-vehicle's propelling chamber.

- Reproduce rocket-re-entry conditions to test new materials of construction for space age.

► **Source of Heat**—Once used

only to illuminate searchlights

and projectors, the high-inten-

sity electric arc makes possible

all these developments.

Arc attains its useful energy concentration when current feeding the anode exceeds a critical level. Resulting arc-density has more heat energy than can be radiated or conducted from the anode tip. Excess energy is consumed as heats of vaporization and ionization by anode or other materials placed near anode.

Too, resulting energy-bearing



*Bright, true colors
made from
dye intermediates
purified with*

DARCO®

What product, famous for purifying chemicals by removing color bodies, also helps keep colors bright and true . . . by purifying a colorless chemical?

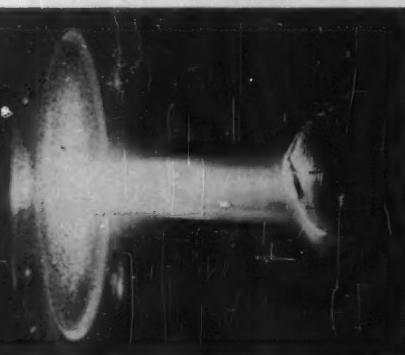
The answer, of course, is DARCO Activated Carbon. Seems that dye intermediates, which may be colorless themselves, contain impurities that could cause false or muddy colors in the finished dye. Intermediate makers find that DARCO does a first-class job of adsorbing these impurities, preventing unwanted side reactions. They like DARCO's low product retention too, because they get high yield along with efficient purification.

If you've got a purification problem, try adsorption with DARCO. It has helped chemical manufacturers get rid of color bodies, odors, colloids, floc-precursors, causes of haze and foam, and other adsorbable impurities for over 40 years. We'll be glad to talk over your application and show you how economically attractive DARCO purification is. Call or write us today.



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 **ATLAS**
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PLASMA spray-coats refractory to protect surface of part.



CONE in plasma undergoes simulated re-entry to earth's air.

positive ions are forced radially away from anode tip, forming the high-velocity, high-temperature plasma jet (tail flame) that proves so useful.

► **Refining On Atomic Scale**—Development work, just completed by Vitro Laboratories, Div. of Vitro Corp. of America for the General Services Administration, proves the feasibility of high-intensity-arc (Hierarc) refining of manganese-rich, Colorado rhodonite ore.

U. S. Manganese Corp., formed by Vitro, Sheer-Korman

Associates* and Great Divide Mining and Milling Corp., plans to upscale successful pilot plant to a Mn-from-rhodonite production facility. When this takes place, the U. S. will no longer have to depend heavily on Indian and Brazilian manganese ore resources.

Rhodonite ore, largely manganese silicate, once required costly, multiple recycle processing to separate manganese from silica. Vitro's Hierarc process accomplishes separation in one step, expends only 2.5 kwh./lb. of processed ore.

Rhodonite is first milled and blended with carbon (15-25%). Extrusion press shapes blend into 2-in.-dia., 44-in.-long anodes. Tunnel kiln bakes shaped anodes for 12-20 hr. at 1,650-1,830 F.

► **Ionizes Continuously**—Anode feeds into Hierarc continuously at 103 in./hr. (24 lb./hr.) rate and vaporizes and ionizes at 13,000-18,000 F.

Charged silicon, manganese and other particles travel length of tail flame into cooler region (4,500 F.) where SiO_2 and MnO precipitate. Air swept into arc, provides excess oxygen for the reaction, quenches arc-product gases and transports product to bag collector. Subsequent leaching recovers pure manganese from this $\text{SiO}_2\text{-MnO}$ mixture.

Upscaled version of Hierarc process will use 6-in.-dia. or larger anodes and will consume less power per pound of Mn produced.

Just another among many applications of Hierarc, piloted at Vitro, is the halogenation of boron to produce boron halides. Halogen gas is piped from cylinders into Hierarc plasma where it reacts with boron from vaporizing anode. This might be applied to the production of high-energy fuels used in jet aircraft.

► **Coating and Fabricating**—Meeting demands for refractory coatings and fabricated shapes to withstand unusually severe rocketry conditions, several companies now offer plasma-coating and fabricating devices

or services. A high-intensity arc generates the required plasma.

Just last month, Linde Co., Div. of Union Carbide Corp., announced its entry into the plasma-jet business, now offers plasma-spray coating and unique fabricating services. (See *Chem. Eng.*, Dec. 15, 1958, p 67).

Giannini Plasmadyne Corp., Santa Ana, Calif. and Thermal Dynamics Corp., Hanover, N. H. sell plasma-generating devices. Giannini pioneered plasma spray coating.

Refractory materials in the form of wire or powder feed into plasma stream and vaporize. Objects placed in refractory-bearing stream condense refractory on their surfaces.

Plasma-jet coating makes possible application of materials such as zirconium diboride on jet-engine parts. Such coatings must resist high-temperature erosion from combustion products of high-energy fuels. Too, high-temperature materials such as tungsten, molybdenum, palladium, metallic oxides and cermets may be applied to nose-cones and other external components of rockets.

Linde's new fabrication technique coats desired refractory material on a brass mandrel within 0.001 in. of desired thickness. By dissolving mandrel in acid, Linde comes up with finished shapes which often cannot be made any other way. One example of this was recent fabrication of tungsten nozzles for rockets.

► **Testing Missile Materials**—High-velocity plasma jets are simulating rocket re-entry conditions in hypersonic wind tunnels set up by General Electric, Linde and others.

A wedge of material placed in the plasma jet's path reveals its resistance to:

- Wide range of temperatures up to 15,000 F.

- Ultra-high gas velocities. Vitro considers it theoretically possible to reach Mach 100 at 0.1 mm. Hg; Linde and G.E. already have attained Mach 2-3.

- Intense radiation density invisible through ultra-violet spectra.

- Superfine abrasive dust (depending on anode material). Severe re-entry conditions,

* Dr. Charles Sheer, Chief Scientist at Vitro Laboratories, and Dr. Samuel Korman did much of early work on Vitro Hierarc.

particularly in the ionosphere, present a real challenge to materials-selecting chemical engineers. Nose-cone materials must withstand thermal shock, ion bombardment, high-intensity radiation and erosion due to high-velocity dust particles or gas.

► **Propelling Rockets, Too**—Several companies under U. S. Air Force contracts now are studying use of electromagnetically accelerated ion flow to propel missiles through space.

Rocketdyne Div., North American Aviation Corp., began operation of a laboratory last month to test their first ion-engine for missiles.

Vaporized cesium, sodium or rubidium metal ionizes when fed into a high-intensity arc housed in a charged chamber. Electrostatic field then forces ions out of ionizing chamber through a 2-ft.-long, 9-in.-dia., cylindrical thrust-chamber.

Although effective velocity of ions is 300,000-400,000 mph., thrust is relatively low. Therefore, ion engine will propel missiles only after they have left the earth's gravitational field.

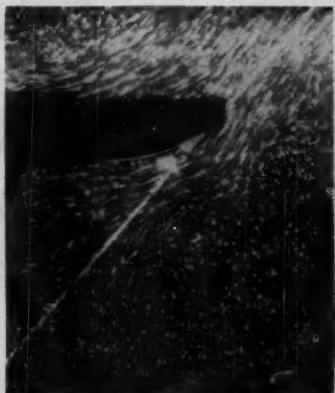
Other companies actively working in this field are Vitro Laboratories, General Electric, Giannini Research, Aerojet-General, Republic Aviation, Goodyear Aircraft and Avco Research.

New Kraft Pulp Process Available to Industry

Patented Sutherland process for making high-yield, high-strength kraft pulps by refining in hot black liquor was recently signed over to the public domain by the Black-Clawson Co.

Process (U. S. 2,591,106 issued to Daniel M. Sutherland) fiberizes coarse, partially cooked pulp suspended in black liquor by passing through Sutherland disk refiners located between the vertical blow tank and pulp washers. Short cooking time gives greater yield of fiber from the wood chips, but requires the positive action of the disk refiner to free all the fibers. Following fiberizing step, pulp is washed and processed by conventional methods.

Process is now being used in several kraft pulp mills under Sutherland license. Black-Clawson had acquired the U. S. rights to the process and is the marketer of the Sutherland refiner.



Water Models Used to Design Turbines, Too

Model studies, in which water flow simulates air flow, is becoming an increasingly popular tool for the design engineer (*Chem. Eng.*, Oct. 20, 1958, p. 70). Westinghouse is the latest firm to employ this technique, using it to perfect designs for steam turbine blades, large fans and other rotating equipment.

Firm lists two major reasons for going to the water models: First, flow patterns in water models are more visible than in wind tunnels. Second, water being denser than air, identical flow patterns are produced with only one-thirtieth the velocity.

Here's how Westinghouse's water tunnel works: Tunnel itself is a vertical pipe, 2 ft. dia. and 20 ft. high. One section is made of clear plastic in which the model is mounted. A 7.5-hp. motor rotates the model while water flows past at an 8,000-gpm. rate. Stroboscopic flash unit photographs the flow patterns, made visible by injecting air bubbles, oil droplets or small plastic particles into the water stream.

A 30-hp. centrifugal pump circulates 13 tons of water through the system. Temperature of water in the tunnel can be varied from room level to 150 F.

Atomic Tempo Quickens In Design and Building

In quick succession over the past few weeks, new developments have been announced in construction and design studies for nuclear reactors.

• Philadelphia Electric Co., spearheading a phalanx of more than 50 private utility companies, has submitted to the Atomic Energy Commission a proposal to design and build a big, high-temperature, graphite-moderated, helium-cooled nuclear power plant.

The \$24.5-million plant, to be completed in late 1962 or early 1963, would have a capacity of 40,000 kw. and produce steam at 1,000 F. and 1,450 psi.

• In another move, AEC approved a design study proposal of Puerto Rico Water Resources Authority for a boiling-water power reactor with a nuclear-fired superheater to boost steam temperatures.

Higher steam temperatures and better plant efficiency would mean expected reductions in unit capital cost and fuel costs.

• On still another front, AEC announced that it will license National Aeronautics and Space Administration for a low-power reactor at Lewis Research Center near Cleveland, Ohio.

Facility will be a zero-power homogeneous research reactor using uranyl fluoride-water solutions as fuel.

Philadelphia Electric Co.'s plant would be built in two stages to meet the limited time schedule set by the U. S. government. Initially, reactor would have metal-clad fuel elements containing homogeneous carbon compacts of uranium (U-235) carbide and thorium carbide, and would produce 30,000 kw. from 840-psi. steam at 850 F. Later, the reactor would use graphite-canned fuel elements.

Conceived by General Atomic Div. of General Dynamics, plant would be built by Bechtel Corp. Westinghouse would be responsible for electric generating system, including the turbine and associated equipment.

The proposal indicated that a 325,000-kw. plant of this type could produce power competitively in many areas of the U. S.



Four-minute CONFERENCE between engineer Bob Christopher and Information Center's Bob Pratt (right) fixes Uniterm language for search, kicks off sequence on next page . . .

Information Retrieval Finds It in Minutes

System at M. W. Kellogg's Information Retrieval Center cuts to minutes the searching time for valuable company documents and boosts engineers' efficiency.

"If you look at it just from the standpoint of how many IBM cards you have, you get a false picture."

So admonishes soft-spoken Bob Pratt, who's supervising M. W. Kellogg's growing information-retrieval system.

"The most important thing," he continues, "is to design information retrieval to meet your needs. What we want is a flexible system, and one that gives us all the important information in the shortest time. For example, we're set up now to do in 15 minutes a literature search that previously would have taken anywhere from one hour to three or four days."

Thus, he encapsulates the thinking that has guided Kellogg's information-retrieval center over the past two and a half years, and made it one of the first companies to establish such a

setup to handle primarily literature generated within the company.

► **A Corporate Memory**—Basic purpose of an information-retrieval center, as Pratt sees it, is to serve as a "corporate memory" retaining vital information from Kellogg's vast research and engineering activities. Eventually, this memory will extend to other divisions such as sales. Of course, information-retrieval center now taps this memory for all Kellogg's activities.

Key to an effective system—one that gives quick, easy access to pertinent information—Pratt asserts, is flexible filing and retrieval and proper selection of documents to "commit to memory." Thus, at Kellogg, a document is given a number of "key words" coded into IBM cards, by which it can be re-

trieved. Key words can be added or changed, and only documents of long-range value (5-15 yr.) are processed for retrieval.

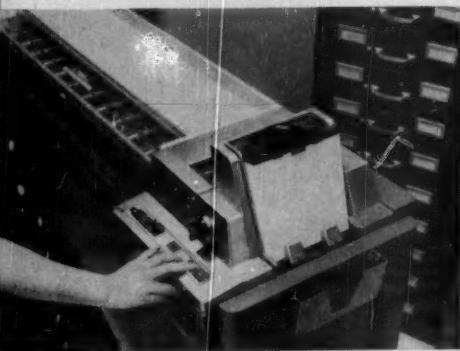
At present, using no more than 5,000 IBM cards, Kellogg has access to 50,000 documents in its retrieval system, covering 1940-1958. Kellogg now files a total of about 1,000 documents per month; about one-third to one-half of these are processed for information-retrieval center. Generally, the engineer who writes a report (or perhaps gets it from a customer) is the one who processes it. Pratt checks and coordinates.

► **A Uniterm System**—Among several possible information-retrieval systems (*Chem. Eng.*, Feb. 10, 1958, pp. 84-86) Kellogg uses what's known as a Uniterm system in conjunction with four-hole-random-punch IBM cards. Machine searching of IBM cards is done with a 1,000-card/min. IBM sorter.

Essentially, Kellogg's Uniterms are key words which stand for ideas and information contained in documents. ("Crack-



10:23 A.M. UNITERMS are coded into their four-punch IBM language.



10:25 A.M. SORT-DOWN is begun with about 1,000 cards in IBM sorter.



10:31 A.M. SEARCH is finished and the document numbers are noted.



10:32 A.M. DOCUMENTS are taken from files and sent to engineer.

... PROCESSES & TECHNOLOGY

ing," "cost" and "naphtha" are typical Uniterms.)

Each Uniterm is represented by four holes, randomly punched in columns 41 through 80 of an IBM card. For example, random punches signifying "cost" are (listing first the number of the column, then the digit punched in that column) 61/0, 68/0, 71/1, 77/8.

Pratt himself designates random punches for new Uniterms, as needed, from the Rand Corp.'s list of 1 million random digits. Kellogg's dictionary of Uniterms now lists about 3,000 in all.

Other information is punched into columns 1 through 27 to identify the referenced document as to date, file location, process, product, company concerned and job number. Twelve columns are thus left available for future use.

Right now, Kellogg is processing documents and listing Uniterms pertaining to design, construction and piping. Pratt feels he will be able to get a very fine breakdown of information with a total of about 7-8,000 Uniterms. Eventually, he expects the system will need about 15,000.

► **Filing and Retrieving**—Here's a simplified rundown on the steps in processing a document for filing and eventual retrieval:

Document is read and an abstract prepared on a 5 × 8-in. index card, listing all information—including Uniterms—that will be punched into the IBM card. The card is prepared and then it, the abstract card and the document are filed separately. Frequently, as many as 20 Uniterms are listed with the abstract and punched into the IBM card.

Retrieving documents pertinent to a search (see photos) is a matter of selecting, say, three or four Uniterms which best define the information desired, and translating them into their four-punch designation. Then with IBM sorter preset (at column and digit of one punch) you make consecutive run-throughs or sort-downs until the cards left give the loca-

tion of all pertinent documents.*

► **For Faster Searches**—Kellogg has incorporated some refinements gained from the experience of other firms.

Pratt plans to keep all cards of one broad process category (cracking, for example) in blocks of 5-10,000. So, in general, you need to search only one block. An exception, Pratt notes, might be patent or legal work where all blocks would be searched.

One big help in keeping the system flexible and up to date is listing Uniterms on a document's abstract card. For it's important to be able to change or add Uniterms and to reclassify documents as the need arises. And you can't be sure, from the holes alone, just what Uniterms have been punched.

There may be a time when you want to consolidate cards in two or more categories under one Uniterm. On the other hand, you sometimes want to get a finer breakdown of a single large category. For example, "cracked naphtha" might be conveniently broken down into Kuwait or domestic crude.

► **Fewer "False Drops"**—With the four-hole random-punch system, there's a statistical probability of a "false drop," a certain percentage of cards in a sort which may have nothing to do with the information you're after (see footnote, below). This probability climbs as you pyramid more and more Uniterms onto a single card.

So, where some users of similar systems pyramid as many as 50 Uniterms on a single IBM card, Kellogg uses additional cards for the document and limits the number of Uniterms to 20 per card.

This cuts the percentage of false drops from about 5% to near 2%.

* Because Kellogg's sorter, under the present setup, can "read" only one punch on each sort-down, the usual procedure is to sort out the first punch of one Uniterm, then sort from the resulting cards the first punch of another and so on. Actually, it's possible to get a "false drop" or card which doesn't pertain to your search, because one punch of a Uniterm may be the same as a punch of an entirely different Uniterm.

15 minutes TOTAL TIME is needed from time engineer confers with Pratt until information is searched and desired documents are located.



Fuel Cells May Star in Satellite Power Picture

Latest of the companies to declare itself officially in the race for an economical portable power package is Lockheed's Missile Systems Div. Lockheed is hurrying development of a fuel cell compact enough to supply the electrical power needs of earth satellites and space vehicles. Above, Lockheed scientist Ross Quinn shows laboratory-size fuel cell can power a small electric motor. Quinn is associated with physical chemist M. Eisenberg, project director.

Lure of generating electricity directly from chemical reactions, with better than 80% fuel efficiency, has been attracting many firms into fuel cell research (*Chem. Eng.*, Nov. 3, 1958, p. 49). Space vehicles are just one of the many potential applications of fuel cells; they could find use anywhere a small, lightweight energy source may be required.

Lockheed isn't disclosing the technical details of its cell, says only that fuel can be "any high-energy compound; gas, liquid or solid; e.g., hydrogen, oxygen or chlorine." While Lockheed did not specify which solids, some existing fuel cells can run on lithium hydride—used as a source of hydrogen. These cells could technically be called solid-fueled.

► **Power Potential**—Lockheed is scaling its model up to a cell that will deliver 0.1 kwh./lb., ten times the power output per pound of an auto battery. In

five years, firm expects to have a cell delivering 0.3 kwh./lb.

One fuel cell expert, commenting on these figures, points out that the weight figure must include the weight of the fuel in order to be meaningful. National Carbon, which jumped into the fuel cell picture a year ago (*Chem. Eng.*, Dec. 1957, p. 154), says that its carbon-electrode cell could also be scaled up to deliver 0.3 kwh./lb. including fuel.

General Electric, also interested in generating electricity in space, is known to be researching fuel cells and thermionic converters—a device for converting heat energy directly to electricity.

New Technique Produces High Vacuum at Low Cost

A new technique for achieving ultra-high vacuums was revealed recently at a meeting of the American Vacuum Society in San Francisco, Calif. Bruce M. Bailey, of Arthur D. Little, Inc., described a system, cryopumping, which can produce extremely low pressures—about one-millionth of an atmosphere—economically enough for large-scale industrial applications.

Essentially an ultra-low-temperature refrigerator using helium as a refrigerant, the first large-scale cryopumping installation is now operating in a hypersonic wind tunnel at the University of Southern California. Bailey believes that cryopumping has industrial potential in any application where diffusion pumps are now used.

Moreover, costs are attractive, Bailey asserts. He cites USC's wind-tunnel installation, where cryopump is powered by a 50-hp. motor. A comparable system using gaseous diffusion pumps would require 500,000 hp.

► **An Old Concept**—Although the cryopump is based on an old principle, practical applications are quite new.

Cryopump consists of a refrigeration unit which circulates gaseous helium at -420 F. through coils in plate condens-

ers. Unit reduces temperature in a system to a point where air or other gases condense, leaving a vacuum. Below the triple point of gases in the system, lowering the temperature results in a sharp reduction of pressure to produce a high vacuum.

Theoretical limit of cryopumping alone is about 0.1 mm. of mercury, which is the sum of partial pressures of noncondensables (hydrogen, helium, neon) in the atmosphere. However, mechanically pumping down to 1 mm., followed by cryopumping, can achieve vacuums of about 10^{-4} mm. Removing noncondensables by flushing the system with nitrogen or Freon should allow vacuums up to 10^{-5} or more.

Bailey explains that cryopumping is now used most efficiently in conjunction with a mechanical pump. This is because pumping rate of a mechanical system falls rapidly as vacuum increases, while cryopumping rate increases.

USC's cryopump freezes out nitrogen at one end of the wind tunnel, causing a flow of nitrogen from the other end over objects being tested. Pure nitrogen is used because triple point (about -345 F.) is high enough for rapid condensation using helium refrigerant. Cryopump's expansion engine consists of two parallel-operation stainless-steel cylinders and pistons, 1½-in. bore with a 2-in. stroke.

NEWS BRIEFS

Dry adsorption: Canadian Export Gas & Oil, Ltd., has installed a dry desiccant processing plant at Steveville, Alberta, to remove hydrocarbons from gas delivered to Trans-Canada Pipe Lines, Ltd., and bound for export. Plant, using silica gel, removes about 66 bbl./day of saleable condensate from 22,000 Mcf./day of gas.

Polyethylene: Dow Chemical Co. has now doubled its original polyethylene capacity at Freeport, Tex., and is building a linear polyethylene plant at Bay City, Mich.



Profitable Brands Start With Cherry-Burrell

Lady Esther Cosmetic Cream must be as smooth and even as the ladies' skin it cares for. Profitable repeat sales of this popular beauty aid depend on reliable, consistent texture.

Cherry-Burrell Superhomo Homogenizers keep Lady Esther Cream smooth and creamy. C-B's high speed shearing action cuts fat globules down to equal size. Steady pumping pressure disperses them thoroughly through the cream. Eliminates any chance of oil separation, any return to the prehomogenized

state. Lady Esther never disappoints its millions of lovely customers.

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setting, refrigerated storing and air unloading, all with efficient flexibility.

A Cherry-Burrell Sales Engineer will be glad to show you how Cherry-Burrell equipment can profit you. There's no obligation. Call or write him today.

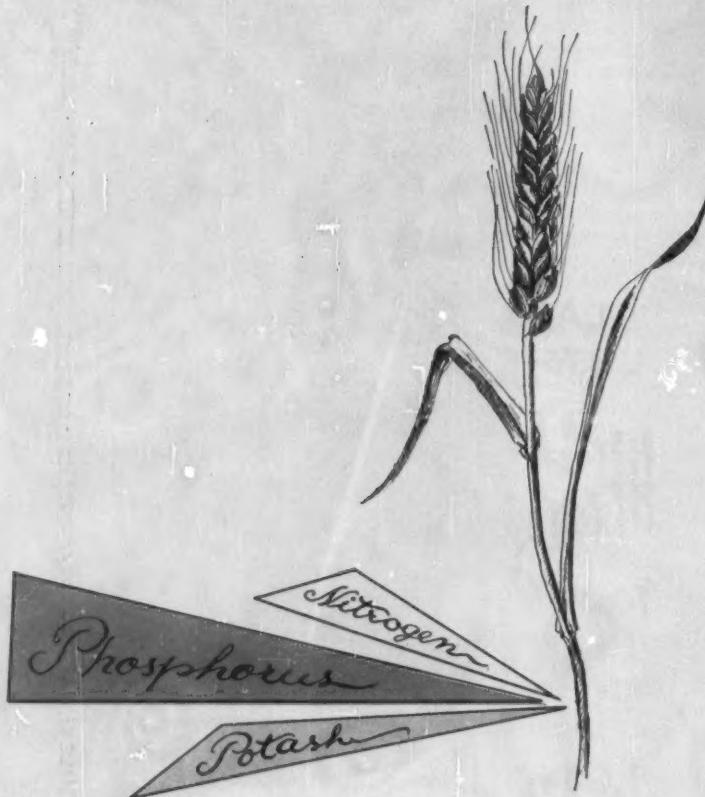


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DEVELOPMENTS . . .

CHEMICAL ECONOMICS

EDITED BY D. R. CANNON



10-10-10
6-18-6
10-30-0
10-30-10
0-54-0

Phosphorus grabs the plant-nutrient spotlight as use of "super" phosphoric acid yields the richest fertilizers ever.

P₂O₅ Is Making the News in Fertilizers

Take a look ahead at fertilizers through the eyes of the Tennessee Valley Authority and you'll see that most of the action centers around phosphorus. On its combination in higher-analysis fertilizers, its recovery from electric furnace sludges and liquors and from low-grade ores.

Eventual benefits from all this "phosphorus" work could range from reduced shipping and distribution costs for fertilizers, added convenience for the farmer, and huge, hitherto-un tapped supplies of phosphorus, fluorine and uranium.

Here are the highlights of TVA's development program for the current fiscal year:

- Liquid phosphorus-nitrogen fertilizers with 50% total

plant nutrient—richer than anything on the market today.

- Concentrated superphosphate, with the highest analysis—54% available P₂O₅—commercially attained.

- Better phosphorus recovery from sludges and liquors in electric furnace processing.

- High-analysis phosphorus fertilizers from low-grade phosphate rock.

- Fluorine recovery in phosphate fertilizer production.

- "Super" Acid—TVA's recent ventures in developing a superphosphoric acid—75-78% available P₂O₅—is beginning to bear fruit. (Top-grade phosphoric acid used in commercial nitrogen-phosphorus fertilizers today analyzes only 54%.)

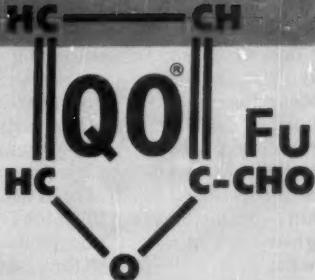
During the past year four fertilizer manufacturers used about 480 tons of TVA's superphosphoric acid in exploratory processes. Additional firms are now requesting the acid.

Results, so far, include production on a demonstration scale of liquid fertilizers containing nearly 50% total plant food (nitrogen, phosphorus and potash). Compare this analysis to the 32% or less plant food content attained with the highest-strength phosphoric acid in commercial use today.

Plans this year also call for using the new acid to produce a superphosphate of exceptionally high analysis—54% P₂O₅ vs. 45-48% for conventional concentrated superphosphate.

SELECTIVITY

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Both structure and physical properties of furfural support its wide use as a selective solvent. This highly polar molecule favors sharp separations of saturates from unsaturates in lube oils, gas oils, cycle stocks, and other petroleum products. It is even effective in separation of organic sulfur compounds, or heavy metal complexes from petroleum fractions. The excellent selectivity is proven daily by the high yields of finished products from commercial installations throughout the world.

Add to this feature the fact that furfural is readily recovered from aqueous or non-aqueous solutions by flash vaporization, straight distillation, steam stripping, or water extraction at surprisingly low cost. The net result—use of furfural is paying off for many people, and it can do as much for you.

Solvent refining with versatile QO furfural is a process worth investigating. May we discuss the matter with you? Write The Quaker Oats Company, Chemicals Department.



The Quaker Oats Company
CHEMICALS DEPARTMENT



Write for Bulletin
203-A, "Physical Data
on QO Furfural"

335N, The Merchandise Mart, Chicago 54, Illinois. Room 535N, 120 Wall Street, New York 5, New York. Room 435N, 48 S.E. Hawthorne Blvd., Portland 14, Oregon. In the United Kingdom: Imperial Chemical Industries, Ltd., Billingham, England. In Europe: Quaker Oats-Graanproducten N. V., Rotterdam, The Netherlands; Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France; A/S "Ota," Copenhagen, S. Denmark. In Australia: Swift & Company, Ltd., Sydney. In Japan: F. Kanematsu & Company, Ltd., Tokyo.

ECONOMICS . . .

► P₂O₅ in Liquids—TVA's superphosphoric acid will speed the trend to use of phosphorus in liquid fertilizers. Cost of P₂O₅ in acid still is higher than in most solid materials. But mixing acid with low cost liquid nitrogen lowers the total cost of applying plant nutrient to the soil. Availability of the new phosphoric acid will help fertilizer mixers come up with liquids which don't salt out, gel, or form precipitates that clog spreading equipment.

In fact, one liquid fertilizer firm found it possible to make stable, highly concentrated liquid fertilizers with wet-process phosphoric acid. The secret ingredient: some superphosphoric acid to sequester the impurities in the wet-process acid.

► Makeup on the Spot — The same firm also used the superphosphoric acid to prepare strong base solutions which could be moved to outlying tank farms for addition of other ingredients and final distribution.

"This couldn't be done," TVA engineers noted, "with conventional acid of lower concentration. You couldn't make base goods with a high-enough analysis to start off with."

Another company found that the best selling mixed fertilizer in its area (14-7-7) can be made with superphosphoric acid and urea-ammonium nitrate solution. With conventional furnace acid, solid urea must be added to provide 90% of the nitrogen. This makes for a costlier product.

The remaining two fertilizer firms made experimental runs with the new super acid to produce liquid fertilizers of higher analysis or better physical properties than could be made with the usual furnace acid. Some of the grades made and sold: 10-30-0, 10-10-10, 6-18-6. **► Fluorine Bonus**—Even TVA's fluorine-recovery project concerns phosphorus. For it's the few percent of fluorine in domestic phosphate rock that TVA is after. The agency hopes to devise a process for economical recovery of byproduct fluorine compounds—now wasted in phosphate operations—in a form suitable for use in the chemical, plastics, steel and aluminum industries.

TVA figures that domestic phosphate rock is abundant enough to supply—given the technology—40% of our domestic fluorine needs, needs which run around 250,000 tons/yr. This would obviously be an important supplement to the free world's dwindling reserves of high-grade mineral fluorspar, now virtually the sole source of fluorine.

TVA hopes to achieve major economies in its fertilizer operations through recovery of other waste products. For instance, Muscle Shoals engineers are trying to boost recovery rate of elemental phosphorus from sludges and liquors in the furnace-phosphorus plant. And at TVA's ammonium nitrate plant, work is moving ahead on processes for recovering hydrogen and nitrogen from waste gases.

► Skimming the Top—Leached-zone phosphate rock, a material occurring in very large tonnages as a covering for higher-grade phosphate ores in Florida, is another target for recovery work. At present the leached-zone material is stripped away and discarded—a waste of some 14 million tons/yr. of this aluminum phosphate ore.

Successful tapping of the enormous reserves of this now-discarded material would make mining of conventional rock more economical and would conserve the shrinking supply of phosphates in the Southeast, a region which traditionally consumes most of this fertilizer.

Looking toward the day when higher-grade rock reserves become less economical to mine, TVA figures the leached-rock material will become commercially attractive. An added bonus is the uranium contained in leached-rock phosphate—a potential reserve (albeit well in the future) against the day when cheaper uranium sources run out. **► Go West**—On the other hand, some developments in the phosphorus field may, by lowering freight costs of plant nutrients from manufacturing plants to farms, accelerate production of phosphate fertilizers from western fields.

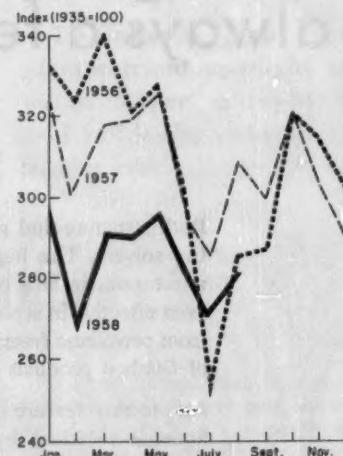
One such development is the already-discussed superphosphoric acid. The second is the wide scale introduction of farm-

ers, under TVA's educational programs, of calcium metaphosphate, which contains 62-64% available P₂O₅.

Central Farmers' Co-op is constructing a plant to manufacture this product, along with conventional phosphate fertilizers, from electric-furnace phosphorus. (Usual practice is to manufacture phosphate fertilizers by acidulation of phosphate rock.)

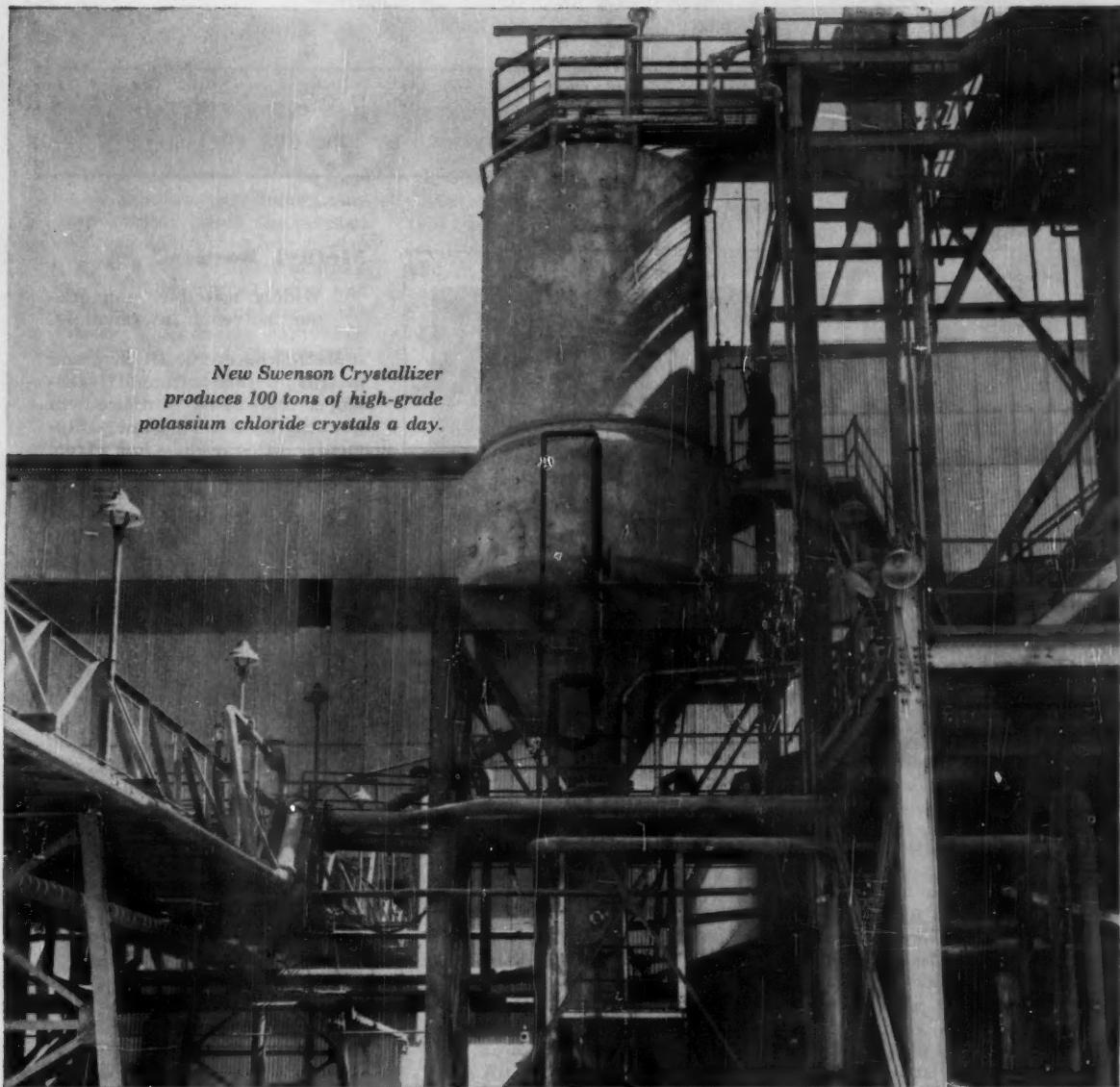
Another new phosphate fertilizer to watch is magnesium ammonium phosphate, made on a pilot-plant basis from olivine (a magnesium-iron silicate) and phosphate rock. This could become an important commercial product—there's a rising need for magnesium nutrient in many farm areas—if pilot-plant and economic evaluations come up with favorable appraisals.

Chemical Consumption



Consumption by Industries

	July (Final)	Aug. (Est.)
Coal products	7.2	7.5
Explosives	8.8	10.5
Fertilizer	53.4	49.6
Glass	27.9	29.2
Iron & steel	11.8	13.4
Leather	4.1	4.1
Paint & varnish	35.0	36.3
Petroleum refining	30.5	31.5
Plastics	19.7	23.5
Pulp & paper	33.0	37.3
Rayon	23.2	23.7
Rubber	5.5	5.2
Textiles	7.7	9.0
Total	268	281



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produces 100 tons of high-grade
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A new Swenson Crystallizer is helping the National Potash Company of New Mexico make KCl (potassium chloride) crystals of the desired size and of exceptional uniformity. The operation is simple and stable. Downtime is minimized due to an unusually long boil-out cycle.

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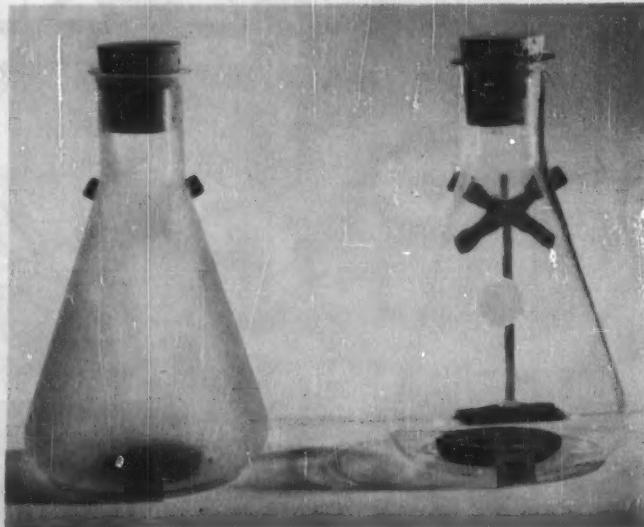


WHITING—MANUFACTURERS OF CRANES; TRAMBEAM HANDLING SYSTEMS; TRACKMOBILES; FOUNDRY and RAILROAD EQUIPMENT

DEVELOPMENTS ...

CHEMICAL PRODUCTS

EDITED BY FRANCES ARNE



No Heat Clouds From Plasticizer-Guarded Vinyl Chip

Vinyl auto interiors will no longer cause windshield fog on hot days if vinyl is compounded with new plasticizer. Flask at right contains vinyl made with new product while flask at left holds vinyl compounded from conventional plasticizer. Cloudiness in the latter resulted after both were heated intensely.

Called Elastex 37-R, plasticizer is a high molecular weight material specifically designed for vinyl compounding.

A medium molecular weight material, Elastex 36-R, has been developed for more general use. —Allied Chemical Corp., Plastics & Coal Chemicals Div., New York, N. Y. 36A

Phenolic Resin

Gives nitrile adhesives improved tensile strength.

A new heat-reactive phenolic resin makes possible the production of nitrile rubber adhesives with excellent green tack, high tensile strength and high thermal softening point.

Designated SP-12, the new resin is an oil soluble, crushed phenolic, characterized by extremely fast cure. It is completely compatible with nitrile rubber and soluble in aromatic or aliphatic solvents.

Laboratory and field tests

have demonstrated that a significant improvement in the tensile strength of an adhesive can be made by milling SP-12 resin with the nitrile rubber before cutting with a solvent. It is usually used in quantities up to 100 parts of resin per 100 parts rubber.

Uses include pressure sensitive, cold setting and heat setting nitrile adhesives for a variety of industrial applications. Good bonds with most porous materials and fair bonds to metal are possible. —Schenectady Varnish Co., Schenectady, N. Y. 36B

Methyl Borate

Widely miscible, nonaqueous solvent, intermediate.

Methyl borate, $B(OCH_3)_3$, and methyl borate-methanol azeotrope, are being produced in quantities that permit shipments in carload lots from Lawrence, Kan.

Methyl borate serves as a catalyst for condensation of ketenes with aldehydes or ketones to form β -lactones. It forms azeotropes with many other liquids and has been used to separate various types of hydrocarbons, especially close-boiling naphthenes, by azeotropic distillation.

It is a neutron absorber and detector. Since combustion of methyl borate forms boric oxide, its addition to plastics, lacquers, enamels and similar materials may reduce flammability of films.—Callery Chemical Co., Pittsburgh, Pa. 36C



Epoxy Resins

They open low-cost way to vacuum-forming molds.

Molds, fabricated with epoxy resins by a newly-developed spray technique, are designed primarily for short-run prototype applications, and give service equal to that of metal molds made by toolmaking techniques.

Construction of the mold be-

gins with application of a release agent on the pattern for the mold. This is followed by coating of the pattern with a gel coat which provides the surface characteristics of the final mold. In the case of small vacuum-forming molds, the gel coat contains flaked stainless steel—to a ratio of 20 to 30 parts stainless to 100 parts resin and hardener—which enhances the surface reproducing characteristics of the epoxy. A first layer of aluminum fiber is applied while the gel coat is still wet.

After the gel coat is allowed to reach a slightly tacky state—a matter of about 20 to 30 min.—a first $\frac{1}{8}$ -in. build-up layer of resin and fiber is applied and compacted, then the second

layer is applied and compacted.

When the formulation has hardened, the mold is removed from the pattern, ready for trimming and installation into the vacuum forming equipment.

Development of the construction technique results from joint research of Union Carbide and A. Gusmer, Inc., developer of the spray equipment.—Union Carbide Plastics Co., New York, N. Y. 36D

Molybdenum

Mb seed treatment can up legume crop 50%.

A new form of the essential element molybdenum can be applied when inoculating seed.

Playing vital roles in nitrogen fixation and utilization, it makes possible increases in crop yield up to 50%.

Called Moly-Gro, it is a combination of three basic ingredients—a special form of molybdenum, the adhesive compound and a sequestering agent. The new material sticks to the seed, providing a uniform coating which won't rub or wipe off during planting or handling. Other forms of molybdenum do not adhere adequately unless mixed with some sort of sticker, a messy and time-consuming step.—Climax Molybdenum Co., New York, N. Y. 37A

BRIEFS

First vinyl wrinkle finish for metals has been developed by incorporating a compound known as Monomer MG-1 into vinyl plastisol, organosol, or solution coating formulations. Difference between rate of polymerization of MG-1 (polyethylene glycol dimethacrylate) and the rate of vinyl resin fusion is believed to cause uniform wrinkling.—Union Carbide Chemicals Co., New York, N. Y. 37D

Hydrochlorothiazide shows promise in current clinical tests of being a more potent derivative of chlorothiazide, company's highly successful diuretic, called Diuril. Called HydroDiuril, the new product—like the old—is effective orally.—Merck & Co., Rahway, N. J. 37E

Nickel bromate, manganese fluoroborate, lead hydroxide (basic) and cobalt (ous-ic) oxide are now available to research chemists for the first time.—City Chemical Corp., New York, N. Y. 37F



Quartz Cloth Makes Plastic Stand Up to 5,000 F.

In flame tests, equal-thickness panels of steel, glass-reinforced plastic, and quartz-reinforced plastic were submitted to an oxy-hydrogen torch for 40 seconds. Flame temperature of more than 5,000 F. melted and burned through both steel and glass-reinforced plastic in less than this time. Quartz-reinforced plastic withstood the flame and retained its structural strength.

Pure quartz is in a newly-developed form: .005-in. dia., continuous monofilaments of fiber. Twisted into thread and woven into cloth on textile equipment, it bids for wide use as a plastic reinforcement in aircraft and missiles on the basis

of greatly improved strength-to-weight ratios. However, the properties of quartz that make it of value as a product, cause difficulties in manufacture that result in a price many times that of ordinary fiber.—General Electric Co., Nela Park, Cleveland, Ohio. 37B

Already available are materials combining the fibers with Haveg resins. Temperatures they'll resist are expected to be far in excess of those limits set by resin-asbestos and resin-glass combinations now being used for exit cones, blast tubes, motor case liners on existing missiles.—Haveg Industries, Wilmington, Del. 37C

For More Information . . .

about any item in this department, circle its code number on the

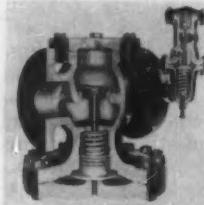
Reader Service

postcard (p. 105)

DEVELOPMENTS . . .

PROCESS EQUIPMENT EDITED BY C. C. VAN SOYE

Latest Developments



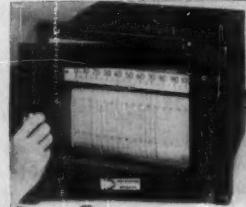
Regulator

For accurate, fast-response control of steam flow. 102A



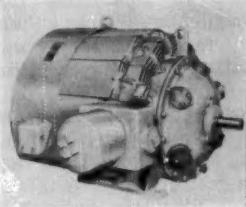
Xerography

Makes news with introduction of automatic printer. 100A



Multipoint Recorder

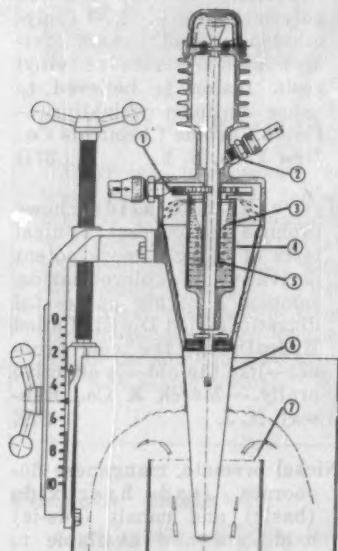
Adapts to a wide variety of recording jobs in just three minutes. 101A



D.C. Motor

Extends range of adjustable speed from 5% to 400% base value. 40D

Page number is also Reader Service Code Number



Consistency Control

Fluid drag forces convert to air resistance.

Although designed primarily for measuring consistencies of stock suspensions in paper mills, the Kolle control system may find other applications throughout all of the process industries. According to the manufacturer, the system will measure and control consistencies between 0.5 and 6% with

great accuracy. Heart of the system is a cleverly designed indicator, schematically shown at the left. Having only one moving part, the indicator is claimed to be rugged and maintenance-free.

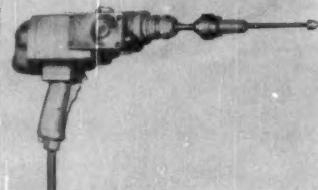
In paper production, the indicator's output activates a controller, which automatically adjusts dilution rates to conform with preset consistency. A recorder keeps accurate records of both dilution volume and consistency.

Here's how the indicator works: A nozzle-ejected stream of water spins a shaft-mounted turbine (1). Water leaving the turbine blades maintains the level within a rotating vessel (4) attached to the same shaft as the turbine. Vessel rotation creates a vortex (3), the depth of which is proportional to speed of spin.

The sensing element (6), which is also attached to the turbine shaft, tends to slow the speed of vessel rotation in proportion to frictional drag exerted by the stock suspension (7).

An air stream introduced at (2) measures, through the bubble-pipe principle, the distance between (5) and the bottom of the vortex. This distance, indicated at the controller as a re-

sistance to air flow, gives an accurate measure of the stock's consistency.—Rosenblad Corp., New York, N. Y. 38A



Expander Drives

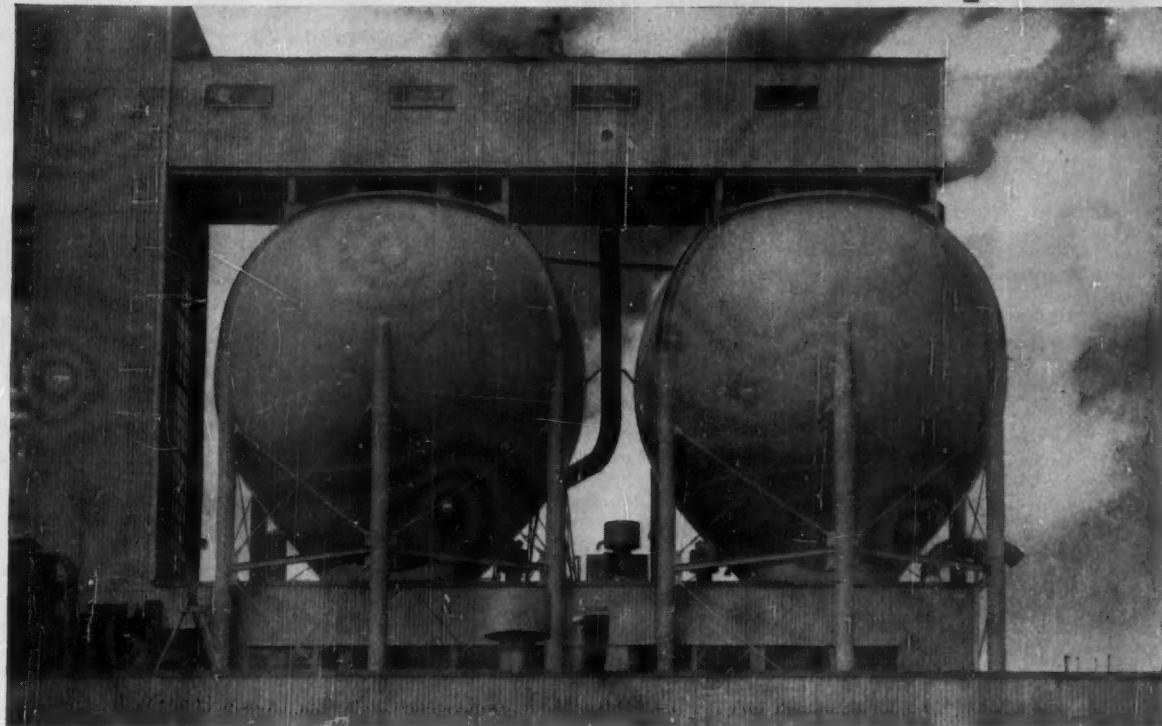
Round out line of tube-rolling equipment.

Two new air-driven, heavy-duty, automatic tube expander drives have broadened the manufacturer's line of Torque-Air-Matic equipment. Both models utilize a mechanical device to measure torque output directly at the mandrel.

Model B, which is designed for use on ferrous or nonferrous exchanger tubes up to 1½ in. O.D., comes in three versions. These range from 38 to 22 ft. lb. torque at 450 to 750 rpm.

Available with 75 ft. lb. of torque at 200 rpm., Model C will roll up to 3 in. in ¾-in. sheet. It will probably find

The Case of the Airborne Conispheres:



Why Linde wanted them . . . How CB&I designed and built them

In order to keep a ready and free-flowing supply of calcium carbide available for generation into acetylene, the Linde Company specified that these two 500-ton capacity Conispheres® be installed on the roof of their Montague, Michigan, plant. In order to overcome a specific set of problems it was necessary for CB&I to incorporate special features into their design and construction. Here's how it was done:

Problem: *Insure safe, continuous operation.*

Solution: (1) Structures were designed to meet a specified emergency condition at an increased stress level, as well as to meet normal service conditions at normal stress levels in all parts not governed by explosion conditions. (2) A series of six safety outlets vent tanks upward. (3) Heavy baffle plates were suspended inside the tanks to control flow of carbide.

Problem: *Tanks must support superimposed load of gallery and feed belt equipment.*

Solution: Special framing distributes load to supporting columns of the tanks.

Problem: *Tanks must be mounted on sloping roof.*

Solution: Three of the supporting columns are longer than others to compensate for roof plane.

Fully coordinated facilities for the design, fabrication and erection of standard or special steel plate structures permits CB&I to work to the most exacting requirements. . . . For this reason industry leaders call on CB&I for the tough jobs and rely on the quality of workmanship that goes into any CB&I built structure. A new booklet describes CB&I FIELD SERVICES . . . write our nearest office.

At Montague, Michigan, Linde is one of three major companies combining their talents and mass production facilities to produce DuPont Neoprene. Linde Company is a division of Union Carbide Corporation.



*A Conisphere is a Horizontsphere® designed with conical bottom outlet.

ES3C

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
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EQUIPMENT DEVELOPMENTS . . .

greatest application in package or power plant boilers.—
Thomas C. Wilson, Inc., Long Island City, N. Y.

38B

Stream Analyzer

Measures boron content in process liquids.

Designed primarily as a process monitor for the manufacture of boron-based fuels, the new MSA boron analyzer is claimed to be accurate to $\pm 1\%$ by volume. Measurement of the total boron content of process streams in borax production is another natural field of application for the new device.

In operation, the instrument actually detects the B-10 isotope. As the process stream flows between a thermal-neutron emitter and a counter tube, the boron atoms capture collid-

ing neutrons. Thus, with rise of boron concentration, neutron incidence at the detector falls off.

This results in a decrease of pulse generation rate feeding through a scaler to the pneumatic recording system. Strip-chart records read directly in terms of boron concentration.—
Mine Safety Appliances Co., Pittsburgh, Pa.

40A

Compressor Controller

Eliminates routine inspection. Lowers maintenance.

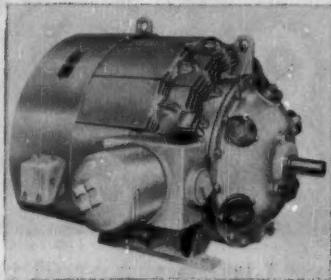
After the start button is pressed, the new Tendamatic automatic compressor control system takes over the job of continuously supervising compressor operation. The system checks air and oil pressures and temperatures, and lubricator

operation. It monitors the float level in condensate traps and watches for leaking valves as well as mechanical failure of running parts.

If abnormal compressor operation occurs, the system gives both audible and visible warnings, and indicates the trouble. If plant personnel take no corrective action, the compressor shuts down.

Tendamatic is available only for the manufacturer's 100- to 7,500-hp. machines.—
Ingersoll-Rand Co., N. Y., N. Y.

40B



D. C. Motor

Has efficient air-to-air cooling system.

Range of adjustable speed offered by a new d.c. motor extends from 5% of base motor speed (constant torque) to 400% of base speed (constant horsepower). To enable such a broad speed range, an integrally mounted a.c. fan supplies a constant flow of cooling air.

For effective air-to-air heat removal, heat exchanger tubes of heavy-section aluminum alloy surround the periphery of the field ring. Air flow through the tubes is independent of motor speed.

Available in ratings from 25 to 300 hp., the motors also feature an explosion-proof enclosure for hazardous areas (Class I, Group D). Special construction also protects working parts from abrasive airborne particles and other severe atmospheric conditions in indoor or outdoor service.—
Louis Allis Co., Milwaukee, Wis.

40D

Automatic Xerography
and other equipment news
on page 100.

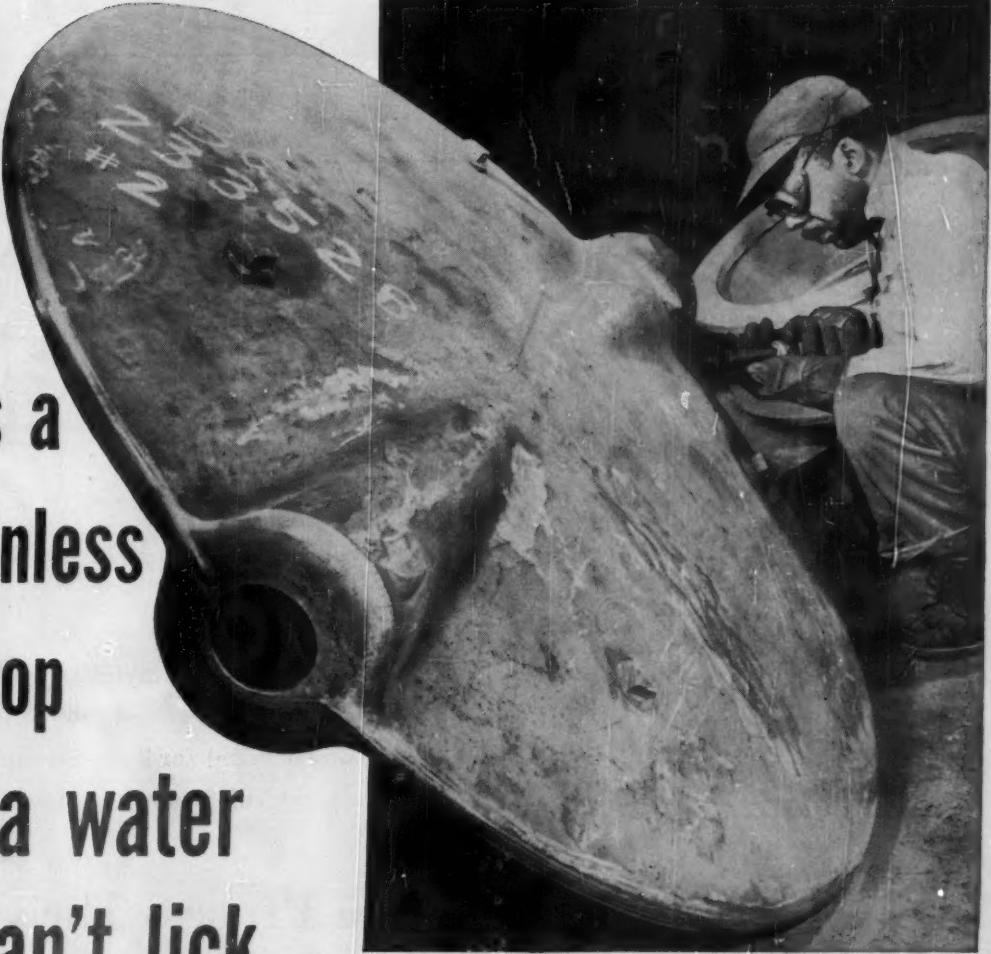


Rubber-Lined Tank to Keep Cleansing Agents Clean

More than 1,000 lb. of crude rubber went into the $\frac{1}{2}$ -in. protective lining on these steel tank sections. When assembled at the Sinclair Mfg. Co.'s Toledo, Ohio plant, the sections will form a huge elliptical blending tank

(18 x 9 x 16 ft.) for compounding liquid detergent ingredients. The rubber lining will prevent metallic contamination of product solution.—
B. F. Goodrich Industrial Products Co., Akron, Ohio.

40C



Here's a stainless lollipop sea water can't lick

This large (48" dia., 1701 lbs.) and unusual stainless casting was fabricated by Allegheny Ludlum's Buffalo, N.Y. foundry. It is scheduled for service under the most severe operating conditions, functioning as a wafer valve disc at 25 psi pressure in sea water. Since long life and tight closing are essential in this application, corrosion resistant Type 304 Allegheny Stainless was specified.

Some unusual techniques were employed in the fabrication of this casting. Although the entire valve disc was

cast as a single piece, its sides are hollow, with a skin only $\frac{3}{4}$ " thick. The center shaft was cast solid at the same time the side wings were cored, permitting the single piece, seamless part desired.

If you have a casting problem, or *any* problem that involves corrosion resistance, long life, resistance to wear and abrasion, call the Allegheny Ludlum Sales Office nearest you. An A-L Sales Engineer is ready to put his skills and those of the A-L Technical Staff promptly at your disposal, to serve your requirements from the largest and most complete line of stainless products on the market.

*Allegheny Ludlum Steel Corporation, Oliver Building,
Pittsburgh 22, Pennsylvania.*

www 6663



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28 pages of valuable and complete data on stainless castings: analyses, properties, technical data on handling and heat treatment, typical applications, how to order, etc.

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**ALLEGHENY
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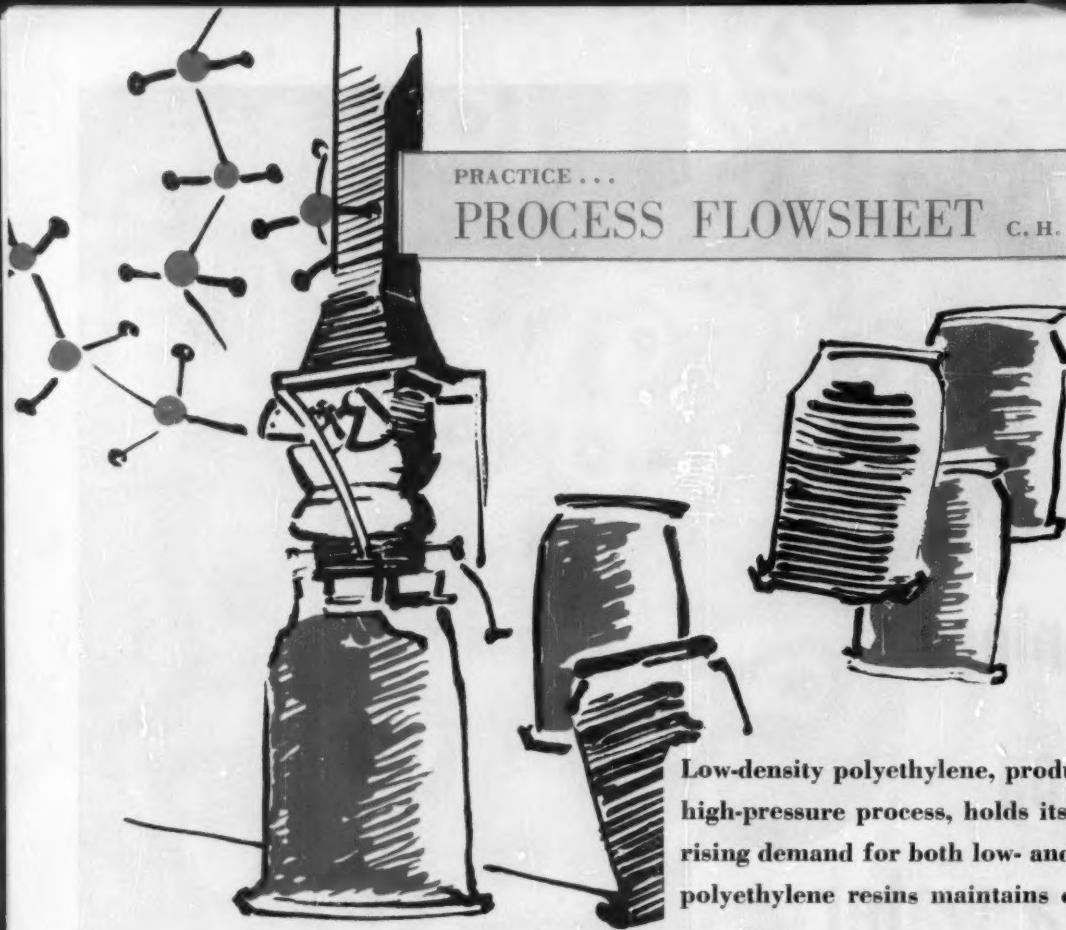
Warehouse stocks carried by all Ryerson steel plants



PRACTICE . . .

PROCESS FLOWSHEET

C. H. CHILTON



Low-density polyethylene, produced by older high-pressure process, holds its own as ever-rising demand for both low- and high-density polyethylene resins maintains even balance.

High-Pressure Polyethylene Process Thrives

IN THIS age, polyethylene film wraps our food, polyethylene bottles feed our babies and dispense our toothpaste. Polyethylene particles condition garden soil and polyethylene hoses carry water to our lawns. In our process plants, polyethylene gaskets seal piping joints and polyethylene packings fill towers.

To meet these ever-increasing demands, low- and medium-density polyethylene producers continue to up capacity aiming at expansion of the already giant 650-million-lb./yr. market. One of these, Spencer Chemical Co., doubled plant capacity this year at Orange, Tex., can now turn out 90 million lb./yr.

Similar growth characterizes market for linear, high-density polyethylene, produced by newer, low-pressure processes. Present market approaches 150-million-lb./yr. mark.

► **Linear's Shortcomings** — These Phillips, Ziegler, Du Pont and Standard Oil of Indiana linear-polyethylene processes use metal-based catalysts to polymerize ethylene in a single pass. Resulting polymer is difficult, sometimes impossible, to separate from often costly catalyst. Too, capital and operating costs are high because plant is larger than high-pressure plant with same output.

But high-pressure process, developed and licensed by Imperial Chemical Industries Ltd. (ICI) and used by Spencer, has disadvantages, too. Costly design is associated with high, 20,000-psi. operating pressure. And using oxygen catalyst, ethylene must pass through a series of polymerization stages. On the other hand, oxygen catalyst presents no formidable polymer-purity problems.

For Spencer's high-pressure

process nearby ethylene suppliers, Gulf Oil, Port Arthur, Tex., and Petroleum Chemicals, Lake Charles, La., pipe in raw, 400-psi. ethylene. Before it can be polymerized, chain-terminating agents and other impurities must be removed.

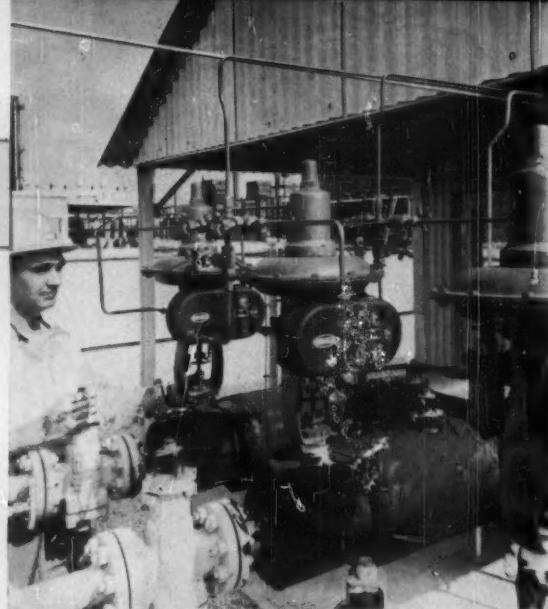
Purification takes two low-temperature distillation steps, one for low-boiling and the other for high-boiling impurities. Raw ethylene (97% pure) feeds to a 70-ft.-high demethanizer column where methane and hydrogen discharge overhead.

Partly purified ethylene bottoms from the demethanizer first pass through a heat exchanger to cool demethanizer feed, then feed the 120-ft.-high de-ethanizer column. Here, purified ethylene (99% plus) discharges overhead while ethane and other high-boiling impurities discharge as column bottoms.

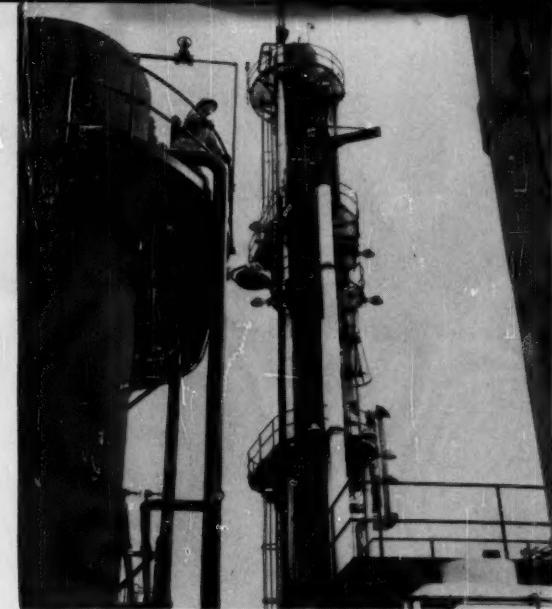
Reflux compressor pressurizes

Unfold Flowsheet →





METERING RAW ETHYLENE: Piped from nearby producers, raw ethylene feeds Spencer's high-pressure process.



PURIFYING RAW ETHYLENE: Demethanizer and deethanizer distillation towers remove the impurities.

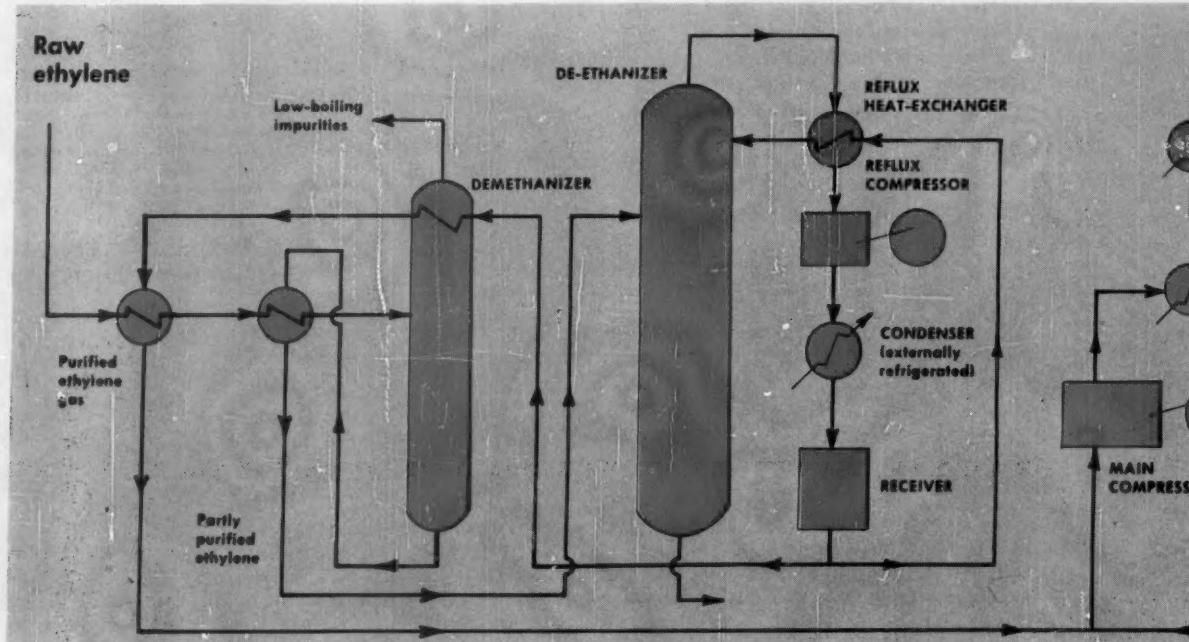
purified ethylene gas. Externally refrigerated condenser liquefies pressurized gas. Resulting liquid ethylene, piped through a heat exchanger in top section of demethanizer, chills escaping low-boiling impurities, thus minimizes ethylene losses. Purified ethylene then passes through another heat exchanger where it vaporizes and precools counterflowing raw ethylene feed.

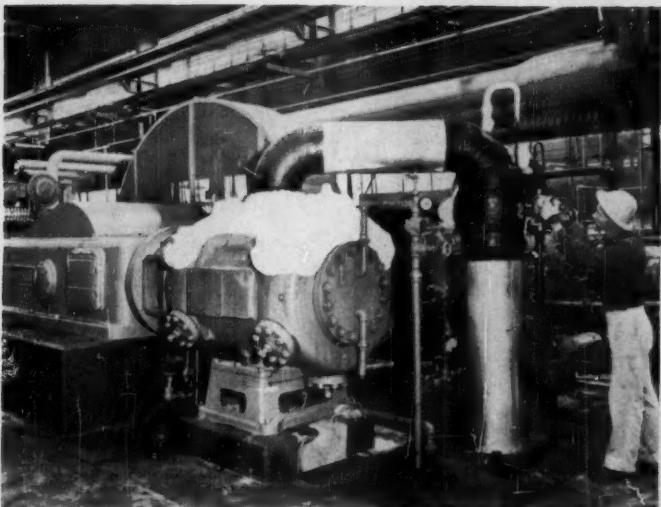
► **The Big Squeeze** — Spencer's huge main compressor boosts ethylene pressure to 20,000 psi., uses 60,000 lbs. of 400-psi. steam hr. in doing so. Heat exchanger adjusts ethylene temperature to 375-410 F. as final preparation for polymerization.

Purified and pressurized ethylene gas feeds a bank of autoclaves where polymerization takes place. Reaction is initiated by a small

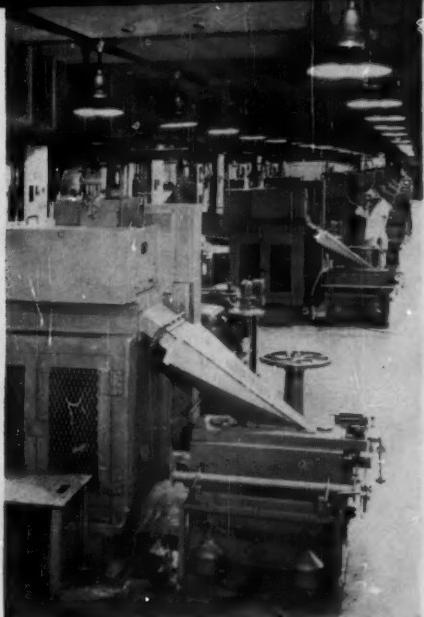
amount of oxygen (less than 0.1%). Polymerization proceeds in several stages so that high reaction heat may be dissipated readily. When plant operates at capacity, more than 1.8 million Btu./hr. will be generated by polymerization. Autoclaves are specially designed to handle heat and at the same time withstand 20,000-psi. operating pressure.

► **Touchy Situation**—Because poly-





COMPRESSING REFLUX-ETHYLENE: Compressor recycles ethylene through heat exchanger to main compressor, then to autoclaves.



CUBE CUTTING: Choppers slice $\frac{1}{2}$ -in. cubes from the extruded and solidified poly-rod.



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merization is ultra-sensitive, elaborate instrumentation regulates catalyst concentration, temperature and pressure. Too-high catalyst concentration or too-low reaction pressure results in an average molecular weight below the correct range (8-15,000). Too-high operating temperature results in reversed reaction and the danger of explosion.

Autoclave product, polymer-mon-

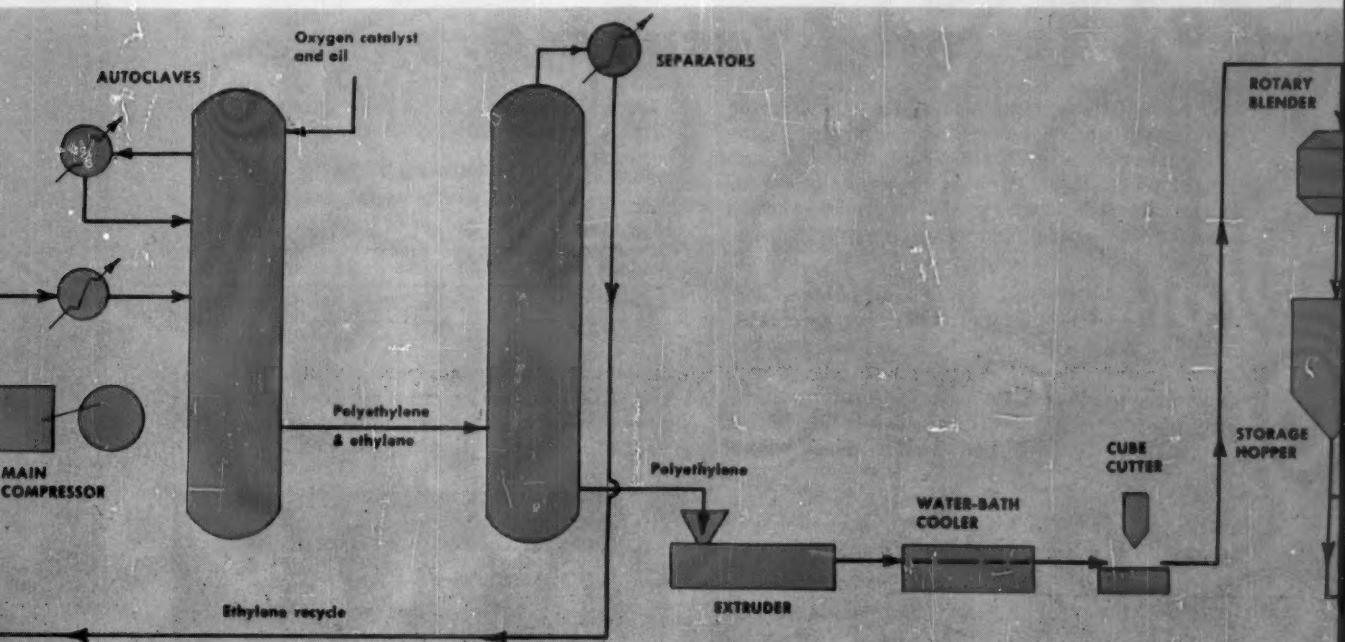
omer mixture, feeds separators where at reduced pressures polyethylene condenses and unreacted ethylene remains gas. Separation proceeds by successively reduced pressure stages to a final stage below atmospheric pressure. Ethylene recycles to main compressor for recompression before re-entering polymerization autoclaves.

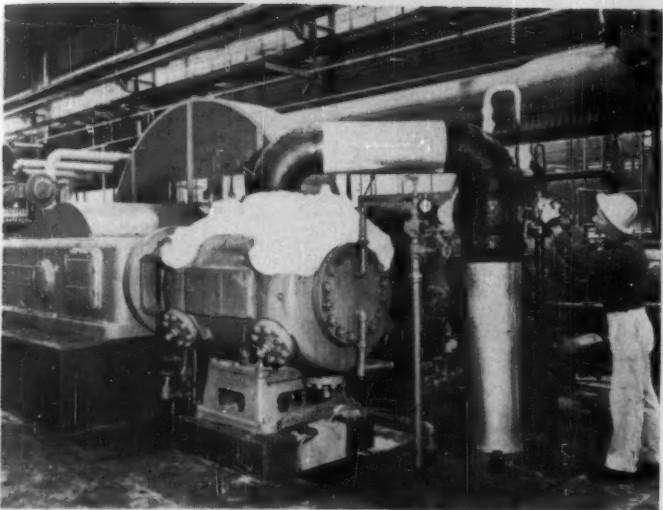
Screw conveyors below separators homogenize, work and force

semi-plastic polyethylene through extruder to form a continuous rod shape. Water bath cools and solidifies extruded rod; cutters chop solid rod into $\frac{1}{2}$ -in. cubes. These are pneumatically conveyed to storage hoppers and blenders.

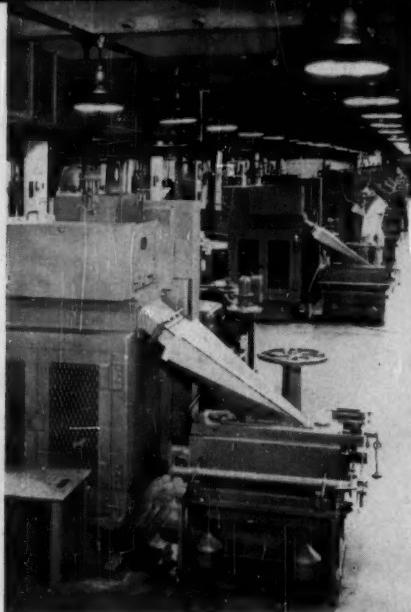
► **Checking Quality Control** — Pneumatic pipe carrier rushes polyethylene samples, department-store style, to control laboratory. Here, polymer product is checked against

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App
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ertiess
polym
for fi
blend
Bar
blend
Carbo





COMPRESSING REFLUX-ETHYLENE: Compressor recycles ethylene through heat exchanger to main compressor, then to autoclaves.



CUBE CUTTING: Choppers slice 1-in. cubes from the extruded and solidified poly-rod.



BLENDING: homogenizers

merization is ultra-sensitive, elaborate instrumentation regulates catalyst concentration, temperature and pressure. Too-high catalyst concentration or too-low reaction pressure results in an average molecular weight below the correct range (8-15,000). Too-high operating temperature results in reversed reaction and the danger of explosion.

Autoclave product, polymer-mon-

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Screw conveyors below separators homogenize, work and force

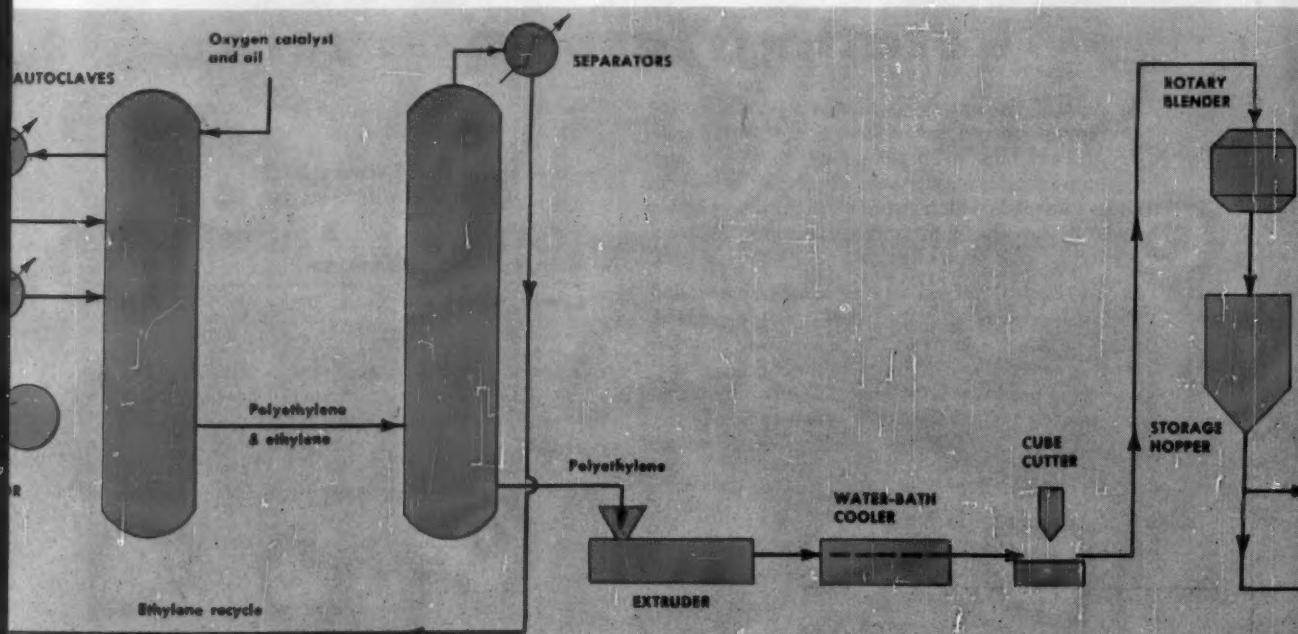
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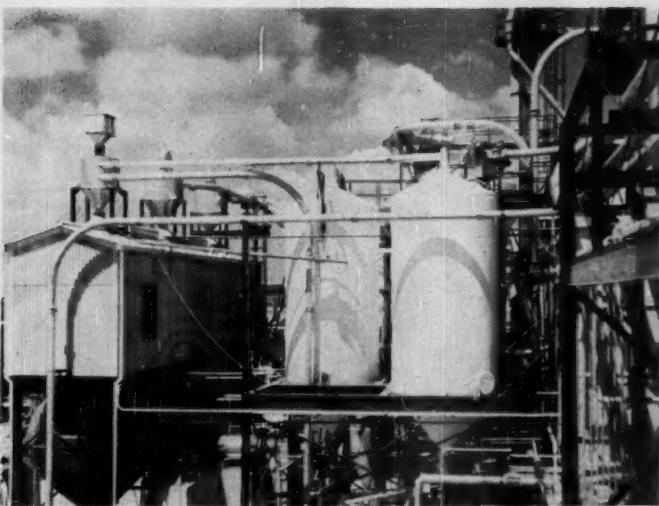
► **Checking Quality Control** — Pneumatic pipe carrier rushes polyethylene samples, department-store style, to control laboratory. Here, polymer product is checked against

appearance and molecular

Approved marketed as additives to improve properties. Polymer can be used for final blending.

Banbury blend additives Carbon black





BLENDING AND STORING POLYETHYLENE: Rotary blenders homogenize cubed polymer product. Hoppers maintain inventory.



STORING POLYETHYLENE PRODUCT: Silos hold the product till it is packaged.

pearance, purity and average-molecular-weight specifications.

Approved polymer may be marketed as-is or blended with additives to improve or protect its properties. Pneumatic conveyor carries polymer either to bagging hopper or final packaging or to additive blending area.

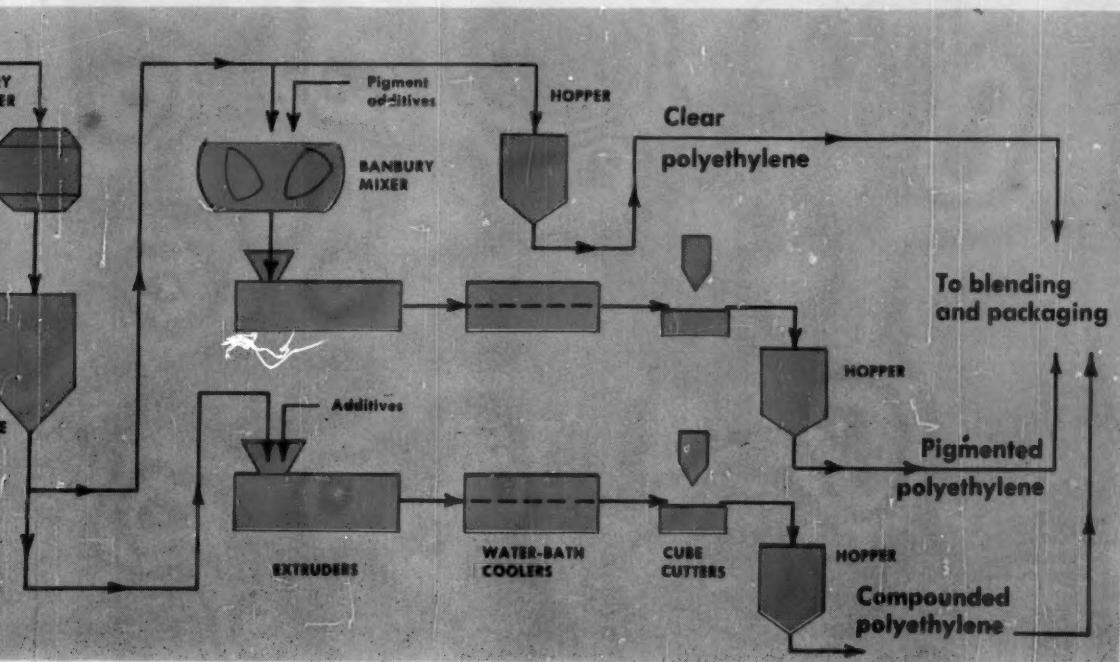
Banbury mixer, extruder, or both, blend additives with polyethylene. Carbon black prevents radiation

degradation, slip agents (lubricants) facilitate fabrication, elastomers increase strength and pigments add beauty.

► **Reshaping Shapes** — Additive-containing polyethylene rods are then re-extruded, water-bath cooled and cubed. Cubes feed into storage hoppers, are homogenized in a rotary blender, checked for quality in the control laboratory and finally bagged.

Final polymer-handling steps are carried out in a "hospital clean" atmosphere. Built-in vacuum cleaners remove dust as compressors feed filtered air to working areas. Materials of construction were selected on basis of cleanliness.

High-purity polyethylene cubes are shipped to fabricators who manufacture the myriads of poly-products for our homes and industries.



"NOW-
WE
CAN BE
SURE!"

*Pump Buyers are saying this
about Peerless Process Pumps—*



FOOD MACHINERY AND CHEMICAL CORPORATION

Peerless Pump Division

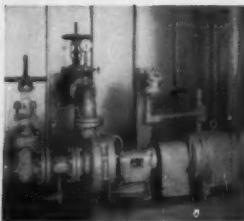
Plants: LOS ANGELES 31, CALIFORNIA and INDIANAPOLIS 8, INDIANA

Offices: New York, Atlanta, St. Louis, Phoenix; San Francisco; Chicago, Fresno, Los Angeles; Plainview and Lubbock, Texas; Albuquerque. Distributors in Principal Cities. Consult your telephone directory.

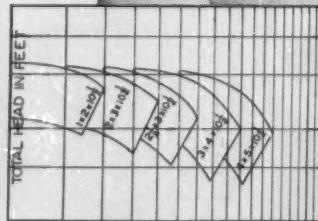
HERE ARE 4 CONVINCING REASONS WHY:



THEY OFFER the type of quality construction that measures up to any standard. Continual checking at every stage of manufacture guarantees the buyer performance he can count on in the field. *The best!*



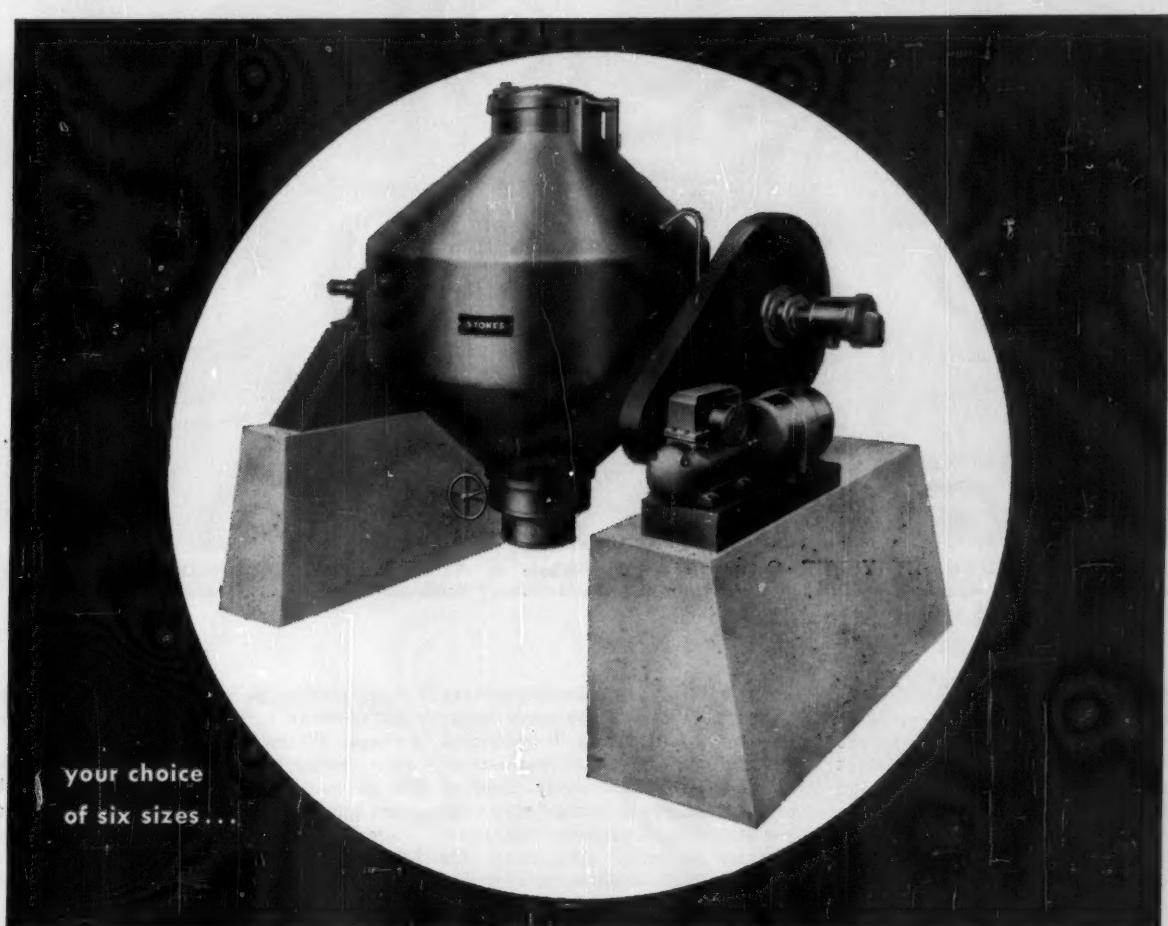
THEY PROVIDE the performance you expect and pay for, backed by actual operating records of Peerless pumps in installations like yours. Durability, dependability, efficiency—all proved in service.



THEY MEET exactly every pumping requirement, handle any job in your system that calls for a pump. The complete Peerless range offers all types of chemical process pumps, in all sizes and frames.



AN EXAMPLE of Peerless research is this recently released bulletin on the effects of radial loads in process pumps, "MECHANICAL CONSIDERATION IN PUMP DESIGN." Request Bulletin No. EM-79.



Stokes Conical-Shaped Rotating Vacuum Dryers

As part of the extensive line of vacuum drying equipment offered by Stokes, this rotating cone dryer is available in six sizes. Built to Stokes' high vacuum standards, they are especially suited for those materials which require the tumbling action and/or the charging and discharging features offered by this type of dryer.

Stokes conical-shaped dryers are double-walled, and include provisions for steam or hot water heating. The interior surfaces can be supplied in carbon steel or in 304 or 316 stainless steel for use with corrosive products. The large, full-opening charging inlet is provided with a quick-acting hinged cover. The discharge port features a self-wiping

vacuum-tight valve, worm-gear actuated. Every drum is vacuum tested by mass spectrometer.

STANDARD SIZES

(special sizes and materials available)

Model No.	159-1	159-2	159-3	159-4	159-5	159-6
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Working Cap.* 3	10	25	75	100	150
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Approx. Wt.	1,750	2,400	3,200	7,700	11,500	12,700
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*In cubic feet—normal working capacity is 65% of total volume

Call on Stokes Engineering Advisory Service for complete information and application data on these and other Stokes vacuum dryers as applied to your own production requirements.

Vacuum Equipment Division
F. J. STOKES CORPORATION
5500 Tabor Road, Philadelphia 20, Pa.

STOKES



F158

. . . But it takes more than a simple stirring, tumbling or agitator action.

In the Simpson Mix-Muller you get a unique three-way kneading, smearing, spatulate action. Materials are not merely stirred or tumbled together. It's an intensive and controlled *mulling* action which eliminates balling, breaks up agglomerates and actually coats one material with the other. Dispersion of moisture, binders or carriers is thorough, uniform and quickly accomplished. You get a mix that stays mixed, one that is unaffected in either storage or transit.

Want proof? Write for details on a confidential mulling survey on your own product . . . conducted under strictest laboratory conditions. Or write for literature.



SIMPSON MIX-MULLER DIVISION

HOW MULLING gives you controlled dispersion for better blends:



GOING:

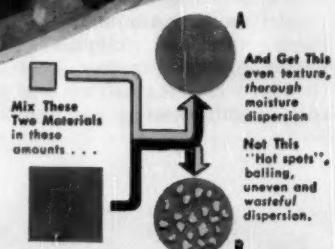
Mix is wetted, dispersion of coating media begins as lumps form.

GOING:

Smearing, spatulate action breaks up lumps as mulling action disperses moisture.

GONE:

Agglomerates almost gone as blending nears completion. Mix is homogeneous, thorough.



Here's how controlled mulling works:

Diagram shows comparative results of blending a minute amount of one material with large amount of another material in (A) MIX-MULLER and (B) conventional mixer. Savings in raw material, reprocessing time and quality of finished product are the outstanding rewards of mulling your product.

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Chemical Engineering

Practice

High-pressure polyethylene plant doubles capacity 42

Ever-rising demand for low-density polyethylene spurs Spencer Chemical Co. to increase capacity to 90 million lb./yr., thus assuring their share in the market.

Estimate the costs of a solvent recovery system 51

If you want to know how much it costs to build and operate systems to recover chemical solvents using activated carbon, here are facts and figures to make your evaluation.

How liquid metals cause corrosive attack 56

Physical solution and diffusion are the dominant factors in determining intensity of corrosive attack in equipment and systems handling molten metals.

Find the costs of joint products and byproducts 61

Proper allocation of costs for joint products and byproducts is a common problem in the process industries. Here are some costing methods based on engineering know-how.

Cost file curves quickly give heat exchanger costs 63

When you're making preliminary equipment cost estimates, these curves for fixed tube sheet exchangers and Karbate floating head exchangers will save you time and effort.

Water-still floats on line via automatic operation 65

Back pressure from condenser builds up when distilled water supply exceeds demand, forces water out of the still and so stops evaporation and steam use.

A medley of technical salary data for 1958 67

Some people save string. We collect salary information about scientists, engineers and management personnel. This is your salary hit parade for 1958.

Hastelloy lining technique cuts vessel cost in half 70

Why use solid alloy when you can save money by lining low-cost carbon steel with difficult-to-fabricate Hastelloy B? Here's how it's done on a large reactor.

DEC. 29, 1958

Department Index

Process Flowsheet	42
Feature Articles	51
Corrosion Refresher	56
CE Cost File	63
Plant Notebook	65
You & Your Job	67
Corrosion Forum	70

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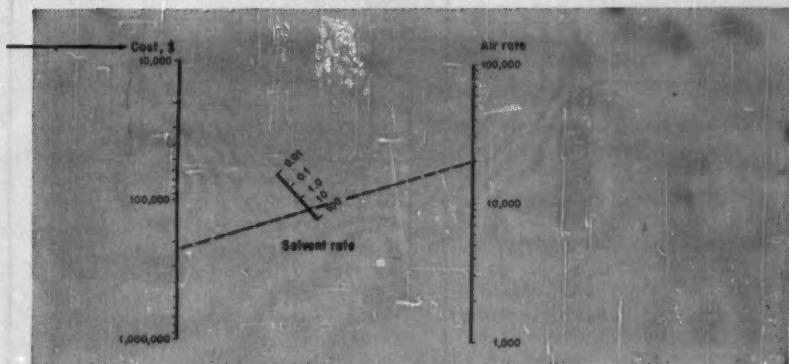


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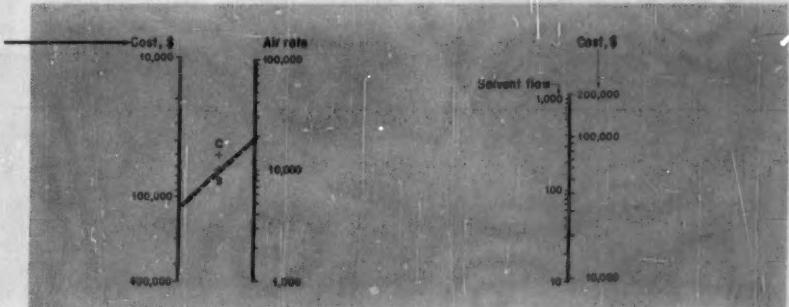
VALVES

December 29, 1958—CHEMICAL ENGINEERING

Basic
Equipment
Cost



Additional
Process
Costs



Directly from charts. . .

Costs of Solvent Recovery Systems

For activated carbon systems, rough estimates of plant and operating costs can be made easily by engineers.

H. L. BARNEBEY and W. L. DAVIS, Barnebey-Cheney Co., Columbus, Ohio.

SOLVENT recovery by activated carbon adsorption was first introduced in about 1922 and has since grown to become a process step of great economic importance. Air, laden with solvent vapors in concentrations from a few parts per million to 100% solvent vapor, is passed through beds of activated carbon, with subsequent steam distillation of the solvent from the carbon bed.

We show here cost data which permit a quick, approximate estimate of capital costs, operating costs and economic bene-

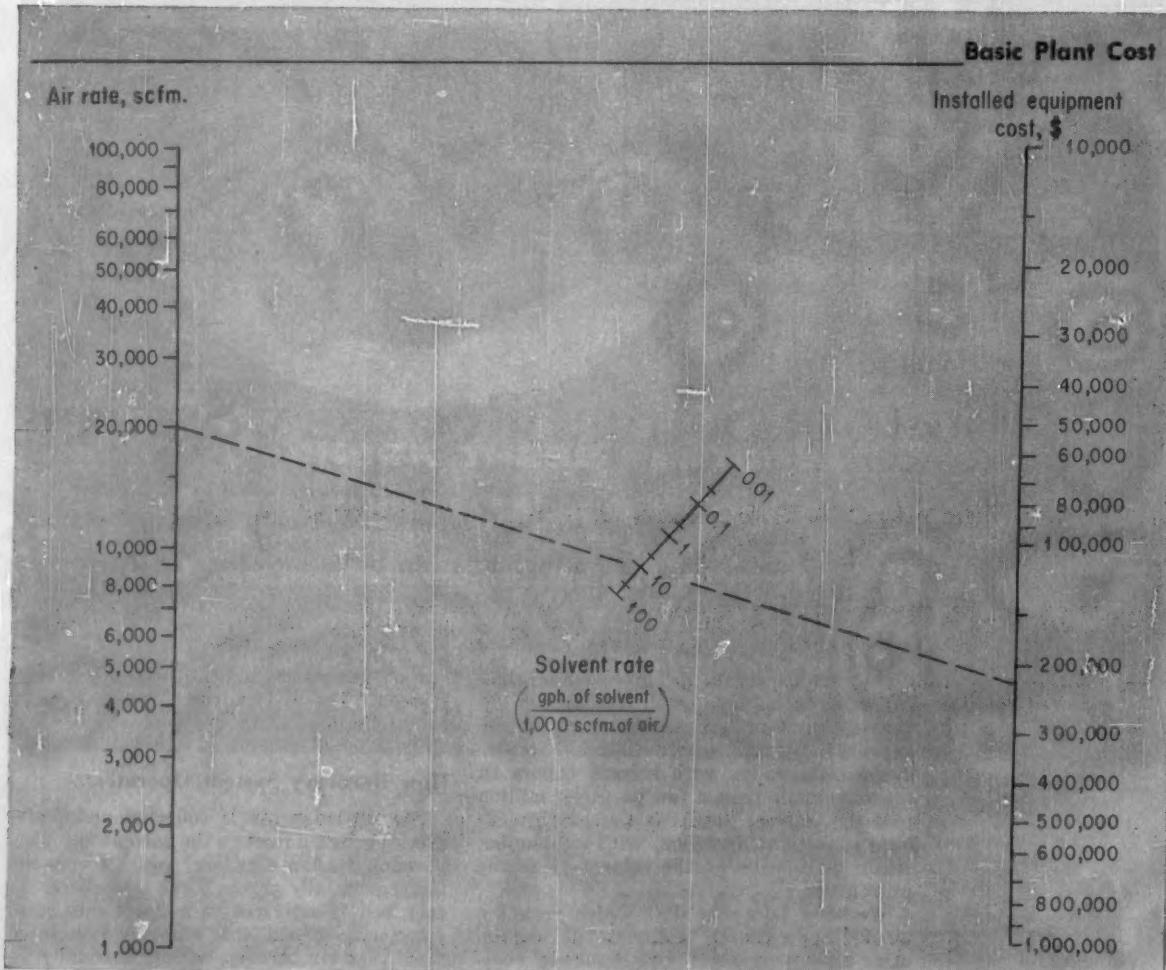
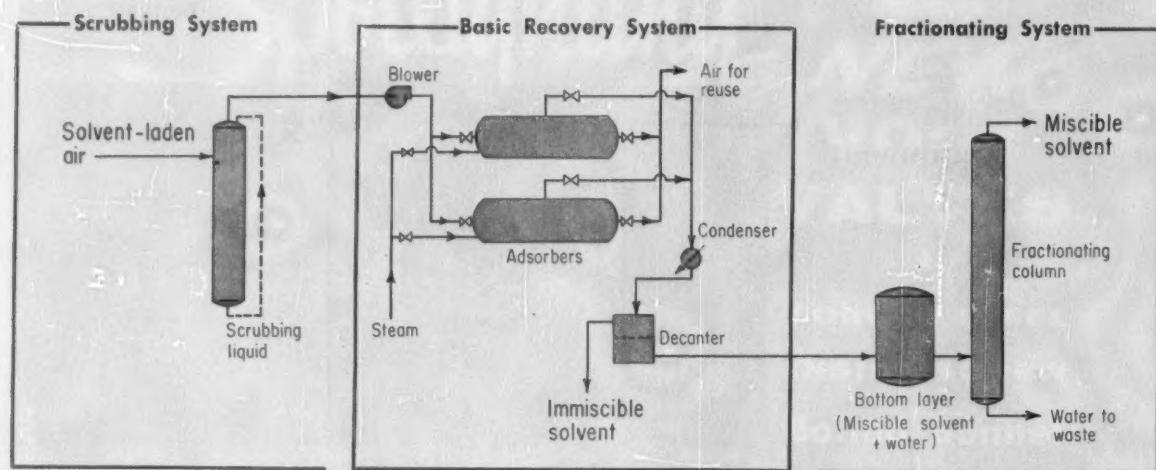
fits of activated carbon solvent recovery systems. These data can form the basis for preliminary economic evaluations.

How Recovery System Operates

Solvent-laden air is collected and delivered through a duct to the solvent recovery blower (see flow diagram) which forces the air sequentially through the adsorbers. As each bed of activated carbon becomes saturated with solvent, that adsorber is isolated from the air stream—either manually or

SOLVENT RECOVERY . . .

Solvent Recovery System



automatically—and steam is admitted to steam-distill the solvent from the carbon bed.

This steam-solvent vapor mixture passes to the condenser where the vapors condense, forming a single or multiphase system depending on the physical nature of the solvent.

If the solvent is water-immiscible (e.g., hexane), the two layers of condensate are separated in a decanter, the solvent layer passing to storage, the water layer flowing to the sewer.

In the case of a miscible solvent (e.g., ethanol), the decanter is eliminated, condensate passing through intermediate storage to a fractionating column where the water is separated from the solvent.

For a mixture of a water-miscible solvent and a water-immiscible solvent, the condensate from the main condenser passes to a decanter which separates the two layers. The top layer (normally called the solvent layer) is generally stored for reuse without further treatment. The bottom layer, containing the water-miscible solvent, flows by gravity to intermediate storage and then to the fractionating column for dehydration.

Cost of Solvent Recovery Plant

To calculate the approximate installed cost of a solvent recovery system for most applications, the following basic information is required:

- Volume of air to be processed, in standard cu. ft./min. (scfm.). Standard conditions are 29.92 in. Hg pressure and 70 F.
- Quantity of solvent to be recovered, in gallons per hour (gph.).
- Physical and chemical nature of solvent or solvent mixture to be recovered.
- Contaminants present in the air stream, if any.

Basic Plant Cost—This item includes the cost of an automatic system of steel construction, comprising dust filter, air cooler, blower, adsorber, condenser, decanter (or run-down tank), interconnecting pipe, valves and fittings. It includes equipment installation costs but no building or collection system for the solvent-laden air.

On the Basic Plant Cost nomograph, connect the system air flow rate in scfm. with the recovered solvent flow rate in gph./1,000

scfm. air, and read the installed equipment cost.

Additional Cost Factors—**Scrubber**: If contaminants (high-boiling plasticizers, phenols, acids or oil vapors)—which might plug the carbon bed or cause corrosion—are present in the air stream in significant quantities, they must first be removed in a scrubber system.

The cost of a scrubbing system is a function of the volume of air processed, in scfm. The scrubber cost is found on the Additional Plant Costs nomograph (p. 54) by connecting the system air flow rate (scfm.) with the point marked "Scrubber" and reading the installed cost of the system.

Corrosion: Certain types of solvents tend to hydrolyze and form acids when desorbed from carbon. Ketones, esters and chlorinated compounds are known offenders. Electrolytic corrosion is always a possibility whenever activated carbon and an electrolyte are present in the same system.

If corrosion is anticipated, stainless-clad adsorbers and stainless solvent process lines must be used, except in the case of chlorinated solvents where glass-lined equipment and Pyrex-brand pipe is recommended.

When corrosion is a factor, additional cost for stainless steel equipment is found by connecting system air flow rate (scfm.) with the point marked "Corrosion" and reading the installed cost on the Additional Plant Costs nomograph (p. 54).

Fractionation: If the solvent to be recovered is soluble in water, provision must be made to separate the components making the solvent available for sale or for reuse.

Assuming that simple fractionation will accomplish the required separation, the fractionating system installed cost is read from the adjacent-scale chart (p. 54) at the required solvent flow rate, gph.

Complex distillation problems are sometimes encountered when separating two solvents, or when dehydrating a single solvent beyond the degree produced by the azeotrope. If such conditions arise, the fractionating cost should be multiplied by a factor of 1.5 to 2.5, depending on the actual complexity of the problem.

Total System Costs—The sum of the basic plant cost plus the additional equipment costs, as required,

gives the total estimated cost of the installed system. To revise these costs at a later date, we recommend making them proportional to the Marshall and Stevens industry average equipment cost index, which was 230 when this article was prepared.

How to Estimate Operating Costs

The Operating Costs table lists recovery costs for typical solvents of the water-immiscible type (toluene or gasoline), of the water-miscible type (alcohol or acetone) and of solvents that cannot be separated by simple distillation (a mixture of naphtha, methyl ethyl ketone and isopropanol).

The recovery cost will also vary with the over-all recovery efficiencies, the size of the installation and the chemical characteristics of the solvent. Therefore, low, average and high costs are given.

The figures in this table represent only the direct costs, including labor at \$2.50 per hr., steam at \$1.25 per 1,000 lb., water at \$2 per 1,000 cu. ft. and power at \$0.0175 per kw. The costs do not include such items as overhead, amortization of the equipment or taxes.

In selecting the proper recovery cost figure, several factors should be given considerations: (1) If high-boiling solvents are to be recovered (boiling range of 200-250 F.), it is advisable to use the high cost of recovery figure as given. (2) If low-boiling solvents are to be recovered (125-175 F.), it is best to select the low figure. (3) If the solvent concentration in the air stream is high (0.3% by volume or higher), recovery costs will be lower, and conversely, for low concentrations (less than 0.3%), recovery costs may be high. (4) If a scrubber is required, or if fractionation is indicated, the recovery cost will be proportionately higher.

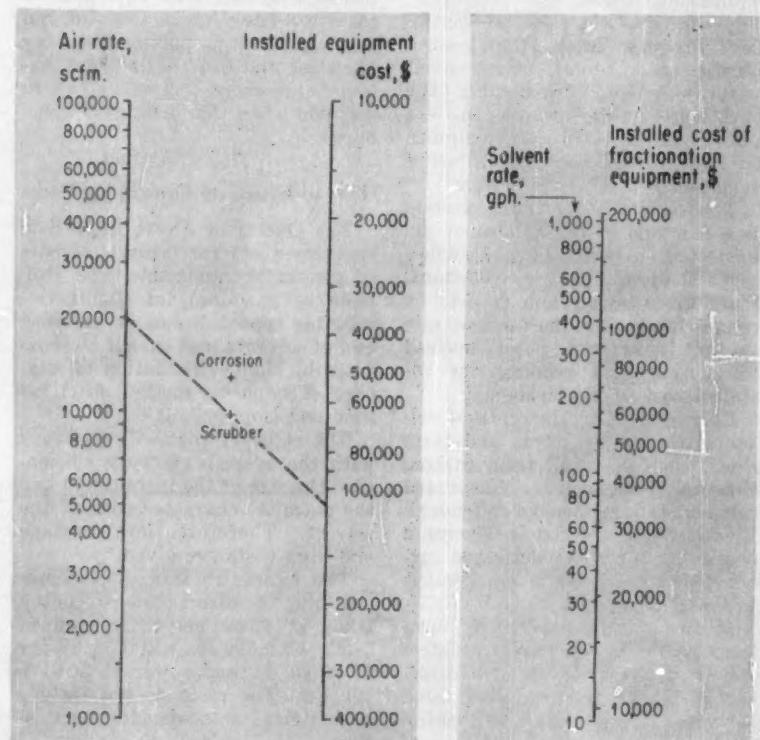
It is also true that the "per gallon" cost of recovery in a large system that recovers thousands of gallons per 24-hr. day will be less than the recovery cost in a small system that operates 8 to 10 hr. per day and recovers only a few hundred gallons daily.

Example Illustrates Method

Here is a hypothetical, but typical, example of a plant operation which needs solvent recovery equip-

SOLVENT RECOVERY . . .

Additional Plant Costs



Operating Costs

Basic Costs, Dollars/Gallon

	Relative Cost of Operation	Low	Average	High
Solvent immiscible in water (decantation)	\$0.015	\$0.025	\$0.040	
Water-miscible solvent (simple distillation)	0.035	0.060	0.080	
Mixed solvent (complex distillation)	0.050	0.080	0.100	

Modifying Cost Factors, Dollars/Gallon

	Add	Subtract
Scrubber required	\$0.01	
High solvent concentration (0.3% by vol. or more)		\$0.02
Low solvent concentration (less than 0.3% by vol.)	\$0.02	

ment. Cost of the equipment and operating costs are determined and the various advantages, benefits and economies are considered.

In a certain process, denatured alcohol is evaporated along with small amounts of phenol, formaldehyde and traces of hydrochloric acid. The solvent loss is 4,800 gal. of alcohol per 24-hr. day, and the plant operates 5 days per week. The air stream carrying the solvent flows at the rate of 20,000 scfm.

What is the estimated installed cost of a solvent recovery system? What will the system cost to oper-

ate? What are the benefits to be expected from the operation of the recovery equipment?

The quantity of solvent to be recovered, in gph./1,000 scfm., is: $4,800/(24 \times 20) = 10$ gph./1,000 scfm. Because of the nature of the solvent, a fractionating system will be required to produce 95.5% alcohol. In addition, phenol, formaldehyde and HCl must be removed by a scrubbing system.

System Cost—To determine the basic cost of the equipment, connect the points 20,000 scfm. and 10 gph./1,000 scfm. on the Basic

Plant Cost nomograph and read the installed cost as \$215,000.

Each of the modifying design factors must now be considered:

Scrubber: Since small amounts of phenol and formaldehyde might be adsorbed in the carbon and might polymerize there, they must be removed prior to the adsorption system. A countercurrent scrubber with caustic solution will effectively remove these contaminants from the air stream and at the same time neutralize trace acid material.

Here, a line through 20,000 scfm. and the point marked "Scrubber" on the Additional Plant Cost nomograph gives a cost of \$110,000 for the scrubbing system.

Corrosion: Since the scrubber neutralizes the hydrochloric acid, and no solvent breakdown is expected, no factor need be added for stainless steel equipment.

Fractionation: Denatured alcohol is miscible with water and a 35% solution of alcohol in water will be produced when a carbon bed is steamed. This product must be fractionated to produce a reusable 95% denatured alcohol.

The solvent recovery rate is: $4,800/24 = 200$ gph. Read on the adjacent-scale chart for fractionation cost factor at 200 gph., the cost for fractionation equipment of \$66,000.

The total installed cost of this solvent recovery plant is then:

Basic cost	\$215,000
Scrubber system	110,000
Corrosion cost	0
Fractionation system	66,000
Total cost	\$391,000

Operating Cost—The cost of operation will be somewhat higher than average, since a scrubber is necessary. Referring to the Operating Costs table, the average recovery cost of a miscible solvent is \$0.06 per gal.; this is revised upward \$0.01 per gal. (to cover scrubber operation) to give a cost of operation of \$0.07 per gal.

Advantages and Their Values

For our example, we've listed and attempted to evaluate the benefits obtainable from a solvent recovery system.

Recovered Solvent Value—Inasmuch as alcohol would normally be purchased in tank car quantities, the price of denatured alcohol SD-1 would be about \$0.50 per gal.

To find the economic justification for the investment before amortization and taxes, the yearly return is determined as follows:

Value of solvent, \$/gal.....	0.50
Cost of recovery, \$/gal.....	0.07
Net value of recovered solvent.....	\$0.43
Gal. of solvent used/yr.....	1,235,500
Gal. of solvent recoverable/yr. (based on 80% recovery)....	988,400
Yearly net operating income of solvent recovery system.....	\$425,000

Increased Safety—The adsorption of 200 gph. of denatured alcohol from the discharge air stream represents a greatly improved operating condition from a safety standpoint. Under certain conditions, it is possible to obtain reduced fire insurance rates by the use of a solvent recovery system.

The installation of an approved fume recovery system can permit a credit of as much as 30% on the base building insurance rate. For a fireproof structure, the base building rate is about \$0.20 per \$100 evaluation per year.

Assuming the building to be valued at \$1,000,000, the 30% credit amounts to a savings of \$600/yr. in reduced premiums.

A second important advantage is elimination of fire hazards. To a plant producing \$5,000,000 in product annually, a single day's loss of production would mean a loss of \$20,000 gross business, with the overhead and profit amounting to an additional estimated \$6,000.

Though most fires cause business interruption for more than one day, for this example it is assumed that the installation of a solvent recovery system will save the overhead and profit caused by a fire resulting in a one-day-per-year business interruption. Thus, we can charge this saving of \$6,000 annually as a benefit to the system.

Improved Working Conditions—It is difficult to assign a dollar value to the effect of increased production and decreased corrosion. But, if the factory employs 75 workers at an average salary of \$4,000 annually, then an increase in productivity of 5%—due to improved working conditions—would amount to \$15,000 annually in equivalent salary.

Pollution Elimination—A flow rate of 200 gph. of ethanol represents a considerable amount of solvent to be contaminating the atmosphere 24 hr. per day, 5 days per

week. The recovery of this solvent will stop pollution and improve neighborhood relations.

In assigning a value to the economic benefit of pollution control, it is evident that benefits derived may vary from a few thousand dollars a year for industrial and public relations costs to several million dollars which might be required if it became necessary to shut down the operation or move the plant to another location.

It seems reasonable to assign a value equal to 0.1% of the annual product value, or \$5,000 here.

Lower Inventory—In our example, we will assume that the reduction in required inventory releases three 20,000-gal. storage tanks for other uses. Also, it is no longer necessary to carry a two weeks' supply of 50,000 gal. of alcohol on hand all the time.

Assuming the 50,000 gal. of alcohol has a value of \$25,000, then the annual interest rate (at 6%) on this amount would be \$1,500. Release of storage tanks, pumps and piping for other uses can be assigned a value of \$500 annually, making a combined annual benefit of \$2,000.

Plant Operation Index—Many solvent recovery users have found that the recovery operation gives them an excellent check on many phases of their factory operation. A decrease or increase in the amount of solvent recovered, or a change in the composition of the solvent may indicate altered manufacturing methods.

To an operation producing a product of \$5,000,000 gross value yearly, operational losses can easily equal as much as 5% of the product value. For this estimate, a figure of 1% is taken, amounting to \$50,000 per year.

Air Recovery—Should it prove desirable to do so, the stripped air may be returned to the operating area for reuse. Such a procedure would save heating costs in winter and cooling costs in summer.

For our example, we have assumed that the average winter temperature is 40 F., and that the 20,000 scfm. of air can be returned to the operating area at 90 F. after the solvent is removed.

If the average heating season is six months long, about 3,400 million Btu. may be saved. At \$0.52 per Mcf. of gas and for an 80% heat conversion efficiency, it is pos-

sible to save \$2,000 per year by returning the air to the operating area in the winter.

Product Improvement—If a solvent recovery system is installed, it then becomes feasible to alter solvent content, or even change the solvent itself, in order to produce a better product.

It is not easy to assign a dollar value to a condition which may improve the quality of a product to the extent that there is no longer any competition. However, for example purposes, an annual value of \$100,000 is assigned.

Total Benefit Value—Summing the dollar values of all benefits, we arrive at the following:

Recovered solvent value.....	\$425,000
Increased safety.....	6,600
Improved working conditions.....	15,000
Pollution elimination.....	5,000
Lower inventory.....	2,000
Plant operation index.....	50,000
Air recovery.....	2,000
Product improvement.....	100,000
Total annual benefit.....	\$605,600

Considering just those items whose values can be tangibly evaluated (recovered solvent value, lower inventory and air recovery), the annual benefit would be about \$429,000. This represents an attractive return on an investment of \$391,000.



H. L. Barnebey



W. L. Davis

H. L. BARNEBEY has a BS in ChE from Ohio State. With Blaw Knox for 12 years, he was sales promotion manager of the chemical plants division. A licensed professional engineer and a member of AIChE and other technical groups, he is now vice president of his firm.

W. L. DAVIS is a chemistry graduate of Ohio State. He has had five years' experience in the sugar industry, and for 15 years has been in research, development and sales of activated carbon applications. He is a member of the Armed Forces Chemical Association.

Corrosion

REFRESHER ON CAUSE AND CURE

Where equipment carries molten metal . . .

Consider Nonoxidative Corrosion

Solubility and solution rates explain intergranular penetration and alloying of materials in corrosive attack by liquid metals.

ROBERT V. JELINEK, Syracuse University, Syracuse, N. Y.*

BY NONOXIDATIVE corrosion we mean the type of attack in which physical solution and diffusion predominate and chemical reaction is not the major cause of destruction. This is the case in corrosive attack by liquid metals. Since transfer of electrons is not involved, the electrochemical concepts which serve so well in treating oxidative corrosion are not applicable here. Instead we must look to principles which control solubility and solution rate to explain nonoxidative corrosion.

Usually we encounter several complicating factors, such as surface films, impurities and temperature gradients, which influence both solution rate and the attainment of solubility limits. Although, nonoxidative corrosion, in recent years, has been the subject of considerable research effort, our knowledge of the interaction of the various phenomena is still rather limited. Hence precise prediction of nonoxidative corrosion rates is difficult and often impossible.

While the handling of liquid metals in refractory containers is commonplace in the metallurgical industries, only recently have chemical engineers become interested in problems involving the flow of liquid metals in metallic systems. The advent of nuclear technology has brought new uses for liquid metals.

Several liquid metals fuels have been proposed for reactor design,¹ including uranium-bismuth, uranium-lead-bismuth, uranium-lead-tin and thorium-magnesium.

Liquid metals are also under consideration as heat transfer fluids in nuclear reactors and other high temperature applications. The best metals² for this purpose are lithium, sodium and potassium because of their low melting points, high boiling points and excellent heat transfer properties. The corrosiveness of all these fluids toward common materials of construction restricts their development.

New uses for alkali metals in the chemical industry^{3,4} further emphasize the need for a better understanding of liquid metal corrosion. Some of the new applications are lithium hydride as a starting material in the production of boron fuels and other organo-metallic compounds; lithium, sodium or potassium dispersions as diene polymerization catalysts and lithium-aluminum-tetraalkyls as catalysts in low pressure ethylene polymerization.

The best available compilations of liquid metal property data^{5,6,7} are presented in the "Liquid Metals Handbooks" and the "Engineering Materials Handbook." Cottrell and Mann⁸ summarize the practical techniques for handling alkali metals. Unfortunately much of the corrosion data presently available is

still qualitative and many gaps in our knowledge still exist.

We know that several types of corrosive attack occur when liquid metals contact solid metals. Manly⁹ lists these as follows:

- Simple solution.
- Alloying between liquid metal and solid metal.
- Intergranular penetration.
- Impurity reactions.
- Temperature-gradient mass transfer.
- Concentration-gradient or dissimilar-metal mass transfer. Variables affecting these phenomena are temperature level, temperature gradient, cyclic temperature fluctuations and surface-to-volume ratio. Additional factors include liquid metal purity, liquid metal flow rate and solid metal characteristics such as surface condition, composition and metal structure.

Since separate control of these factors is difficult to achieve, we see that design of corrosion tests and quantitative interpretation of the resulting data are not simple matters. Most of the tests reported in the literature determine the performance characteristics of specific container materials rather than at fundamental study of mass transfer effects. However, we can at least determine qualitative conclusions about these effects.

Two operating variables of principal interest to the design engineer are temperature and flow rate.

*To meet your author see *Chem. Eng.*, Nov. 17, 1958, p. 154.

We know that as temperature increases both diffusion rates and the solubility of the solid metal in the liquid metal will increase. When a temperature gradient exists in a liquid metal system, we can expect solubility differences between the hot and cold areas to cause mass transfer.

Cyclic variation of temperature at any one location or in the entire system can cause alternate solution and precipitation, particularly when solubility varies sharply with temperature. Manly⁹ cites experience with the copper-bismuth system. In this system at 500 C., corrosion rate is several times faster when the cyclic change in temperature is ± 5 C. than when the change is ± 0.5 C.

Fluid motion plays the same role in nonoxidative corrosion that it does in other diffusional operations. Increasing flow rate aids mass transfer and reduces effective thickness of interfacial films. A study of mass transfer coefficients¹⁰ for the solution of several different metals in liquid mercury shows that the coefficients follow the same general correlations developed for liquids. However, reliable data are still lacking for other corrosive metals. At exceptionally high flow rates, we can expect erosion effects to become important particularly if precipitated metallic crystals become suspended in the flowing metal.

The ratio of exposed solid metal surface area to volume of liquid metal may be an important factor in establishing corrosion rate in static systems or ones in which the liquid metal is recirculated. In such cases the solid metal may corrode sufficiently to approach saturation in the liquid metal. Consequently, corrosion increases as the ratio of surface area to volume decreases.

Surface condition of the solid metal is important in the initial stages of operation prior to the establishment of steady state conditions. However, surface condition can affect corrosion test results, particularly if the tests are of short duration. Furthermore, impurities such as oxides and nitrides introduced on the solid metal can alter corrosion rates. The effect of these impurities is most noticeable with the molten alkali metals.

Composition of the exposed surface and the metallurgical structure of each component are im-

portant factors throughout the period of exposure. If more than one solid metal is exposed to the liquid metal, then dissimilar metal mass transfer occurs. Under this condition, the corrosion rate generally increases.

Grain size affects corrosion¹¹ because wettability of individual grains is different from that of the grain boundaries. Grain boundary structure is also a variable since the presence of carbides or oxides can accelerate intergranular attack. Finally, as in electrochemical corrosion, local stresses must be considered, since they can modify surface structures and affect solution tendencies.

Types of Liquid Metal Attack

The most elementary case is the simple solution type where the metal surface corrodes uniformly at a substantially constant rate. If the phase diagram for such a system is known, the extent of corrosion and depth of attack can be predicted readily from the solubility limit at the prevailing temperature. The rate of attack must be measured experimentally or estimated from a knowledge of mass transfer coefficients at the conditions of exposure.

However, system impurities can modify corrosion rates substantially even in cases of simple solution attack. Uniform corrosion occurs primarily with pure metals, although it has also been observed with rather complex alloys¹² such as Type 304 stainless steel in molten sodium.

When solution of the liquid metal is possible in the solid metal, alloying may occur. The extent of this type of attack is also predictable when the phase diagram is known. However, corrosion rate is more difficult to estimate than in simple solution attack because we must know the diffusion rates in the solid phase.

When the solid phase contains more than one component, entry by the liquid metal is likely to displace one of the components of the original alloy. Alloying attack has been observed in the corrosion of vanadium by lead, copper by sodium and type 446 stainless steel by lead. The last of these examples is shown in Fig. 1.

Selective solution of one component from an alloy causes inter-

granular penetration. Eventually disintegration of the alloy structure occurs. Alloys¹³ in which one constituent segregates at the grain boundaries are particularly susceptible to this type of attack. The best known example is the selective removal of nickel from austenitic stainless steels by lead or lithium. The resulting intergranular corrosion is shown in Fig. 6.

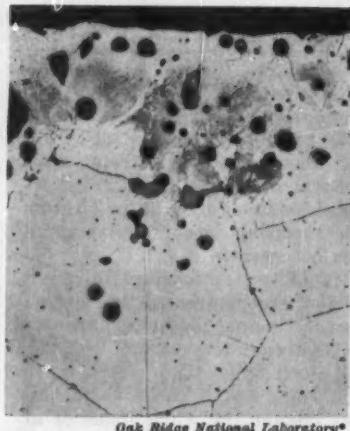
Impurity reactions are difficult to predict except from actual experience. Principal impurities are oxygen, nitrogen and carbon. Not only will such impurities affect corrosion rates but in some cases they may change the whole mode of attack¹⁴ because of the reactivity of the impurity or its effect on surface tension. Even minute quantities can cause serious difficulties. Experimental delineation of impurity effects is almost impossible because of analytical limitations.

The influence of nitrogen on corrosion of type 316 stainless steel in lithium is a good example¹⁵ of impurity effects. After 100 hr. exposure to pure lithium at 870 C., attack is slight (about 0.002 in.). But upon addition of only 0.1% nitrogen to the lithium, the full thickness (0.035 in.) is penetrated as shown in Fig. 2 for the same exposure conditions. In this instance, the attack mechanism¹⁶ is reaction between lithium nitride and the carbides which form the grain boundary network.

Oxide impurities are difficult to avoid in alkali metals. Their oxides are extremely stable and alkali metals reduce surface oxides present on container metals. The presence of oxide impurities in sodium has been found to increase precipitation in cold sections of nickel alloy and stainless steel systems. Carbon impurity in sodium or lithium can result in severe carburization of high temperature alloy.

Since most liquid metal systems show rather steep solubility curves and isothermal operation is difficult to achieve even when desired, temperature-gradient mass transfer occurs. In this type of attack, we define temperature-gradient mass transfer as the solution of metal in warmer locations and its precipitation in colder locations in a system. Thus, not only is corrosion accelerated but cold-zone precipitation can lead to plugging of circulating systems.

CORROSION REFRESHER . . .

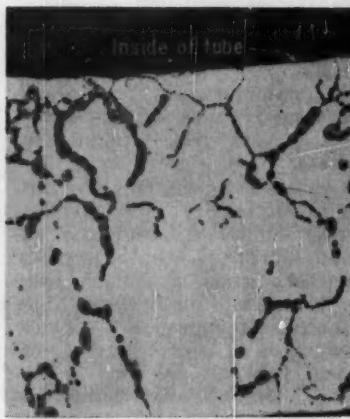


*Oak Ridge National Laboratory**

Alloying

Liquid metal: Lead at 1,000 C.
Specimen: Type 446 stainless steel.
Result: After 400 hr. immersion, lead diffuses into alloy along grain boundaries.

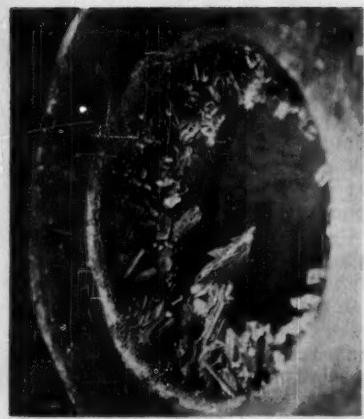
Fig. 1



Impurity Reactions

Liquid metal: Lithium with 0.1% Li_N at 870 C.
Container: 316 stainless steel tube.
Result: After 100 hr. exposure to lithium, nitride impurity reacting with carbides along grain boundaries causes failure of tube.

Fig. 2



Temperature Gradient **Fig. 3**

Liquid metal: Lithium at 1,000 C.
Specimen: Type 410 stainless steel thermal convection loop.
Result: After 40 hr. operation, lithium dissolves iron from hot part of loop and carries it to colder section where iron precipitates.

Mass transferred metal may nucleate in the bulk liquid or on piping walls as shown in Fig. 3. Over-all corrosion rate in a system with a temperature gradient will be determined by the relative rates of solution in the hot zone and precipitation in the cold zone. With molten lead circulating in thermal convection loops, the rate controlling step is found to be solution in the hot zone. Formation of diffusion barriers¹¹ reduces plugging in the cold zone.

The last type of liquid metal corrosion is concentration-gradient mass transfer. This is caused by exposure to the corroding fluid of dissimilar solid metals capable of alloying with each other or forming solid solutions. One solid metal is dissolved by the liquid metal and conveyed to the other metal surface where it deposits. For example, sodium transfers nickel in this way to molybdenum surfaces as shown in Fig. 4.

We must consider concentration-gradient attack not only in designing liquid metal transfer systems but also in performing corrosion tests. The marked increase in corrosion of type 304 stainless steel is evident when we compare Figs. 5 and 6.

*All photographs courtesy of Oak Ridge National Laboratory.

Manly⁹ suggests that tendency toward mass transfer attack can be predicted from large differences between the chemical potentials or high mutual solubility of two solid materials.

Liquid Metal Corrosion Tests

At this point it is appropriate to comment on liquid metal corrosion tests. There are three basic categories: (1) static screening tests, (2) dynamic performance tests and (3) fundamental studies of solubility and mass transfer. Considerable work has been done in the first two categories, resulting in an encyclopedic accumulation of data. These data can be interpreted and correlated only qualitatively. Rarely have different groups of tests been run on the same basis and almost always no attempt was made to control impurities.

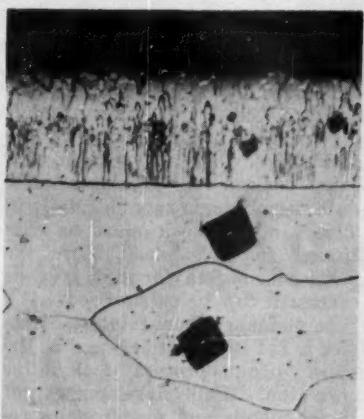
Much of this testing was done in connection with the development of nuclear reactors and many of the results are still unavailable in the open literature. However, we hope that these data will be declassified soon. A few fundamental studies have been published. More work is needed before we can understand mass transfer phenomena in liquid metals as well as we do analogous processes in ordinary liquids.

Static tests are usually performed by sealing samples of liquid metal into small capsules of test metal or by suspending test metal specimens in a closed vessel containing liquid metal. After a desired period of exposure at a controlled temperature, the results are determined by chemical, metallographic or mechanical testing of the specimens.

Chemical analysis of the corrosive liquid metal, though desirable, is often omitted because of analytical difficulties. Use of multiple samples and statistical treatment of data are helpful since results are not always wholly reproducible.

Specimen weight-change data are likely to be misleading. Contrary to the usual result in oxidative corrosion, weight loss does not always occur in corrosion by liquid metals. Even in severe cases of intergranular corrosion, weight changes may be essentially negligible.

Miller¹⁰ suggests microscopic examination as the best single technique for evaluating attack by liquid metals. Microscopic examination permits ready differentiation between different types of attack and identification of attendant phase changes. Quantitative measurement of intergranular phenomena, diffusion layers and extent of material removal is possible

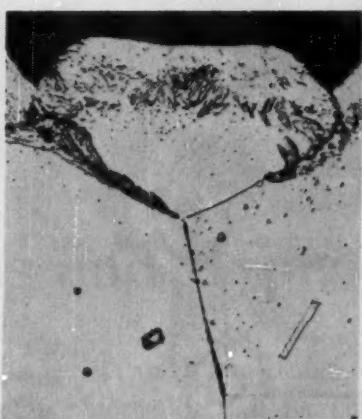
**Concentration Gradient Fig. 4**

Liquid metal: Sodium at 1,000 C.

Container: Nickel

Specimen: Molybdenum

Result: After 100 hr., nickel dissolves in sodium. Sodium carries nickel to molybdenum surface where interalloying occurs.

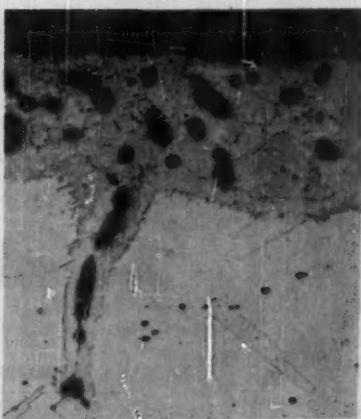
**Dissimilar Metal Transfer Fig. 5**

Liquid metal: Lithium at 1,000 C.

Container: Type 304 stainless steel

Specimen: Type 304 stainless steel

Result: After 400 hr., only slight attack occurs at grain boundaries of test specimen.

**Dissimilar Metal Transfer Fig. 6**

Liquid metal: Lithium at 1,000 C.

Container: Iron

Specimen: Type 304 stainless steel

Result: After 400 hr., removal and transport of nickel to iron container causes severe attack along grain boundaries of specimen.

microscopic. Sometimes X-ray analysis is used.

Static tests are rapid, relatively inexpensive and best for general screening of available container materials for possible use with a given corrosive metal. However, their results do not always correlate with those obtained in actual service. For this purpose dynamic tests simulating intended service conditions such as flow rate, temperature level and gradient are best. Both thermal convection and forced circulation loops are used in dynamic tests.

Conventional pumps are usually unsatisfactory for handling liquid metals. Fortunately their electrical properties make possible the use of electromagnetic devices for pumping and flow measurement in corrosion test loops and in large scale application.^{3, 4, 5}

Our earlier discussion of types of attack makes it evident that several precautions are necessary to assure validity of corrosion tests. First, the metallurgical history and surface preparation of the test specimen should be carefully controlled and consistent with test objectives. Second, the container should be made of the same material as the test specimens or of known inert material thus minimizing undesirable mass-transfer

effects. Third, protective atmospheres must be truly inert. With active alkali metals, the best way to purify a blanketing gas is to bubble it through a separate container of the liquid metal.

Finally, impurities in the liquid metal should be known and, so far as possible, controlled. This is extremely important since many inconsistencies⁶ in liquid metal corrosion data can be traced to impurity effects.

As noted above, fundamental study of mass transfer phenomena has only begun. Dunn, Bonilla and co-workers⁷ investigated mass transfer of several metals in mercury. Ward and Taylor⁸ reported rate constants for the solution of copper in lead and bismuth.

Epstein⁹ has made a mathematical study of the problem and preliminary analysis of available data on alkali metals. He points out that the usual liquid correlations familiar to most chemical engineers are applicable only to systems controlled by diffusion in the bulk stream. Mercury systems are of this type but Epstein has found that in lithium and sodium systems mass transfer rates are controlled by solution processes at the solid-liquid metal interface.

A study of mass transfer¹⁰ in liquid lithium sponsored by the Na-

tional Science Foundation is presently under way at Syracuse University. This work employs a forced-circulation system designed to permit measurement of solution rates in a heated zone and deposition rates in a cooled zone. A flow sheet of the test loop is given on the next page.

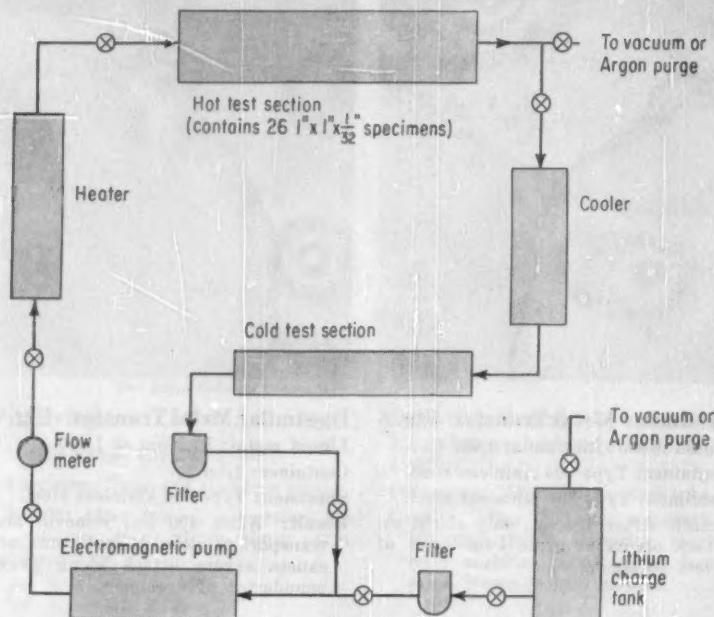
More fundamental work of this kind is urgently needed, first, with pure liquid metals and, then, at known impurity levels to establish the role played by contaminants. Mass transfer in liquid metals may become an important area of chemical engineering in the near future.

How to Control Corrosion

Understanding corrosion mechanism is the key to its effective control. For the present, our principal means of controlling liquid metal corrosion is to use construction materials which we know are resistant. Some thought is being given to the development of inhibitors. Taylor¹¹ suggests these may be of two types: scavengers to remove impurities or film-forming substances to set up diffusion barriers at solid surfaces.

Barium, strontium or calcium have been proposed as scavengers¹² for molten sodium systems and titanium¹³ for lithium systems.

Test Loop Yields Data on Mass Transfer Effects



Powdered chromium and aluminum were found effective in retarding mass transfer of nickel¹⁹ in molten caustic. We may anticipate refinement of these proposals and later still other methods of control through environment modification.

We should broaden our discussion to include nonmetallic materials and fluids. Information on corrosion resistance of nonmetallic materials is given in the "Engineering Materials Handbook." Generally, ceramic materials exhibit poor resistance to molten alkali metals. Graphite resists sodium and potassium well but not lithium.

Standard references on refractories^{20, 21} discuss the corrosive effects of metals and slags encountered in practice. Little research has been done to establish the fundamental mechanisms of attack. Both chemical and physical processes are possible in causing this type of attack.

Components of a ceramic or refractory may dissolve in the melt contacting it and be carried away by diffusion and bulk motion. Phase transformations can occur and attack may be intergranular in nature. Slags or nonmetallic melts are more likely to react with refractory solids than are molten

metals. These complicate analysis of the problem since three phases are present. Physical properties of the solid are likely to be important. Nonporous and completely fused materials are probably the most resistant.

Norton²² discusses the chemical reactions between refractories and slags and glasses. We know that ceramic and refractory materials are of considerable interest in jet and rocket development. We hope that some fundamental knowledge on corrosion mechanism will evolve from the research activity in this area. For the immediate present, the results of this work are likely to remain classified.

In several common chemical processes, molten salts or alkalies are handled in large quantities. However, little is known about the fundamental mechanisms by which such substances corrode materials of construction. In such cases attack may be either chemical or physical. Uhlig²³ includes some qualitative information about the resistance of metals to molten salts in his discussion of high temperature corrosion.

Three recent articles^{24, 25, 26} report the results of a corrosion study of nickel-molybdenum-iron alloys and

Inconel in molten sodium hydroxide at temperatures up to 815 C. Selective removal of iron, chromium and molybdenum was found to occur together with intergranular deposition of corrosion products including oxides and sodium oxy-salts. Good photomicrographic data permit some rate calculations. This kind of work must be continued and expanded before the basic phenomena for this type of corrosion can be categorized.

In summary, nonoxidative corrosion is not as well understood as the more common process of oxidative corrosion. Full development of liquid metals and molten salts requires a better understanding of corrosion phenomena and effective methods of control. Good work is underway but the field still presents many challenging research opportunities.

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How to Deal With Costs of . . .

Joint Products and Byproducts

With this article and a knowledge of process alternatives, you can help provide more objective standards for allocating product costs.

A. F. DERSHOWITZ and H. R. MCENTEE, General Electric Co., Waterford, N. Y.

COST systems are vital to the health and growth of any industry. They direct valuation of inventory so that profit or loss data can be made available to business owners and the tax collector. They assist in the minimization of manufacturing costs. And, they provide guidance to whoever sets product prices.

If each step of a plant operation produces only one product grade, the setting of costs is simple, as all costs can be charged against that grade. Frequently in chemical operations, however, a process will produce a mixture of several grades. Or, several alternate processes or sets of process conditions will produce various mixtures of the same grades. The problem of set-

ting a cost on each of the several grades is one of *joint costing*.

If all grades but one are completely unusable, the problem again reduces to the simple costing of a single grade. However, an intermediate condition exists where moderate amounts of some grades are usable, but an excess still exists. Here we enter the problem of *byproduct costing*.

Note that we define a byproduct as a material that is produced coincident with the production of another, desired material, and is partially, but not completely saleable or usable.

Systems for Cost Control

For process operations that produce custom materials to meet each customer's own specifications, cost control depends on a *job cost* accounting system. Each order is individually estimated and costed. We are not considering this type of system here.

Many process operations, however, produce a standard list of saleable products for stock. Accounting procedures for these operations usually follow a *standard cost* system. In such a system, each raw material, intermediate and finished product has a standard cost, set on the basis of a budget. Actual costs are compiled and then compared with the cost standards to arrive at figures for process cost savings.

One particularly effective form of a standard cost system is the so-called *direct cost* system.¹ In this, all accounting transfers for a plant turning out intermediates or fin-

ished products are made on the basis of "direct costs." These include only the variable elements of cost such as material, direct labor, utilities and normal maintenance. All remaining text in this article applies primarily to direct cost systems.

Allocation of Joint Costs

A standard accounting text² lists two methods of allocating joint costs. The first is to use the same unit cost for all products.

In the second method, costs are allocated according to sales value. That is, any product which is sold to the customer for twice as much as another product is given a unit cost that is twice as high. Unit costs are adjusted to liquidate the total cost of the operation.

While these two methods possibly represent the range of alternatives for the meat-packing business, they are not always the most appropriate for the chemical business. However, a third method—the engineering alternate—is particularly applicable to chemical processing operations.

The engineering alternate system for joint costing considers that, either by introduction of alternative processes or by alteration of process conditions, it is frequently possible (at various costs) to produce varying product mixes. Let's illustrate how this works.

Engineering Joint Costs

Assume that a unit of *D* produces 0.5 lb. *X* and 0.2 lb. *Y*. Each unit of *D* costs \$0.10.

A. F. DERSHOWITZ, presently a process and economics engineer in the Silicone Products Dept., is a graduate of MIT, where he also teaches during summer semesters. He is active in AACostE, ASQual, Control and AIChE. Dershowitz holds a PE license in New York State.

H. R. MCENTEE is engaged primarily in process development, process design and economic evaluation. He has also taught applied mathematics to company classes. An associate member of AIChE, McEntee is a recipient of both BS and MS degrees from the University of Michigan.

PRODUCT COSTS . . .

Also, an alternate process exists, in which a unit of B produces 0.1 lb. X and 0.5 lb. Y . Each unit of B costs \$0.15.

If both processes are running, the yields of X and Y will be:

$$X = 0.5D + 0.1B \quad (1)$$

$$Y = 0.2D + 0.5B \quad (2)$$

Now, if we want to operate so as not to have any byproduct, solution of Eqs. (1) and (2) will tell us how many units of D and B to run for various demands of X and Y . Thus:

$$D = \frac{5.0X}{2.3} - \frac{1.0Y}{2.3} \quad (3)$$

$$B = \frac{-2.0X}{2.3} + \frac{5.0Y}{2.3} \quad (4)$$

Obviously, these equations apply only in the region:

$$\frac{2.0X}{5.0} < Y < \frac{5.0X}{1.0}$$

This, of course, is the region of joint rather than byproduct costing.

If we apply unit costs to Eqs. (3) and (4) we find that:

$$C_D = 0.10D = \frac{0.5X}{2.3} - \frac{0.1Y}{2.3} \quad (5)$$

$$C_B = 0.15B = \frac{-0.3X}{2.3} + \frac{0.75Y}{2.3} \quad (6)$$

And since the total cost C_T is the sum of the costs of running D and B :

$$C_T = C_D + C_B = \frac{0.2X}{2.3} + \frac{0.65Y}{2.3} \quad (7)$$

From Eq. (7), we can see that $0.2/2.3$ is the unit cost of X , and $0.65/2.3$ is the unit cost of Y . Since our two processes are controlled by Eqs. (3) and (4) to give no excess of X or Y , each additional pound of X will cost us \$0.2/2.3; likewise, each additional pound of Y will cost \$0.65/2.3.

Limitations of Third System

This third system of joint costing is particularly applicable when cost is the significant factor guiding pricing decisions, rather than when pricing guides allocation of costs. The system is also very helpful in clarifying thinking when there are three or more joint products and processes. It is subject to error, however, when there is poor judgment in the selection of relevant processes and their costs.

It is also subject to error when some of the process combinations

have a definite capacity limitation. If this is the case, production from the limited unit virtually constitutes a "fixed cost," and costing may be based on the remaining processes. Or, if a process combination is affected, a capacity function may be included in Eqs. (1) and (2). This results in the appearance of a capacity term in Eq. (7). The term must then be reallocated to X and Y .

In a complex case, we should check on the validity of the desired unit costs in ranges of production that are likely, but perhaps beyond the range of the correlation. The preferred way of doing this is to extend Eqs. (1) and (2) to include all relevant inequalities and capacity limitations. Total costs over a wide range of X , Y , . . . , etc. are then computed by linear programming^{2,3}, and compared with costs predicted by the unit costs derived above. In this way, we can avoid serious pitfalls.

Byproduct Costing Systems

From the standpoint of manufacturing cost control, the only cost of a byproduct that will not confuse production efficiency with byproduct utilization is zero. Nonetheless, we continue to be concerned about byproduct costing for two good reasons.

The first is that some production people in businesses dealing with expensive products wish to detect sloppy handling of anything, byproducts included. As a second reason, there is the risk that byproduct consumption will grow to the point where byproducts really become products. At this point, existing price patterns may be unprofitable.

Costing on the basis of this second criterion involves evaluation of a risk in terms of dollars. This risk cannot, we feel, be properly evaluated on any purely formal basis such as the costing of byproducts identically with the main product, based on total pounds used. Nor should evaluation of risk follow the scheme of costing byproducts in the ratio of sales value to sales value of product, based on total pounds used.

From the engineering standpoint, the first question is: "How would we make more of the byproduct if it became a product?" Frequently, the answer to this question

represents a process modification that is cheaper in total cost than our existing process, and is based on our accumulated experience on how not to make our existing product. Joint costing of our byproduct with the existing products, taking into account this process modification, will give us an estimate of potential relative cost.

The second question is: "What is the probability that this potential cost will apply instead of the current cost of zero? Evaluation of this probability requires judgment of both marketing and new product developments, of course.

Find Byproduct Unit Cost

For a given year, in the absence of marketing information, an estimate of the above-mentioned probability might be:

$$\text{Probability} = \frac{\text{Budgeted consumption}}{\text{Budgeted production}}$$

Or, when inventory is extremely high:

$$\text{Probability} = \frac{\text{Budgeted consumption}}{\text{Budgeted production and inventory}}$$

Our suggested byproduct unit cost C_s , can thus be defined by the equation:

$$C_s = \text{Potential cost} \times \text{Probability}$$

One advantage of this formula is that it converges to the correct joint cost as consumption grows; sudden upsets in the cost system are thus avoided. Another advantage is that the formula maintains a good cost incentive for the guidance of marketing when byproduct consumption is low.

Note, however, that the formula has some disadvantages. It underestimates the profitability of byproduct sales at any point under full consumption. It also requires more work and judgment than any simple approximation. Nevertheless, the formula does result in fuller utilization of engineering judgment in setting byproduct costs.

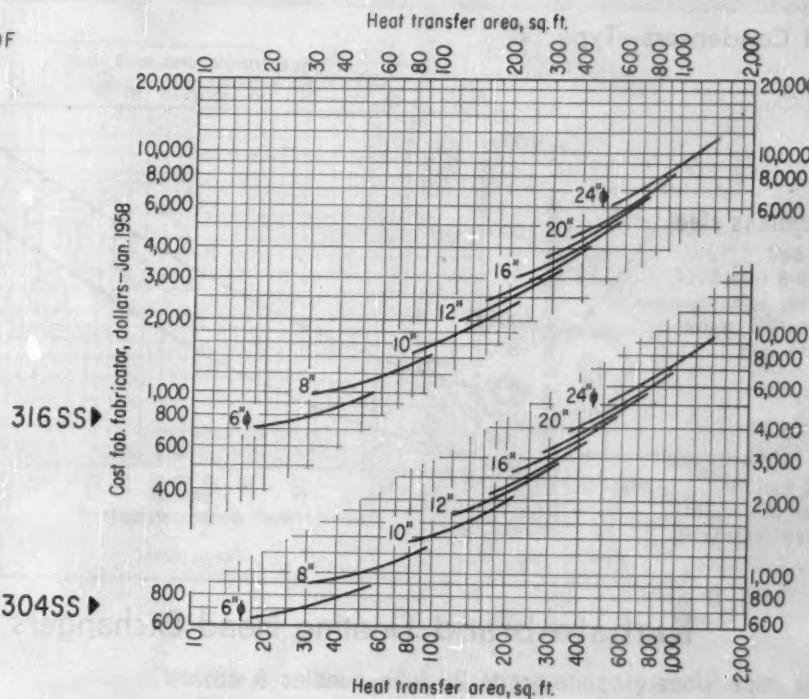
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No. 9 Floating Head & Fixed Tube Sheet Heat Exchangers

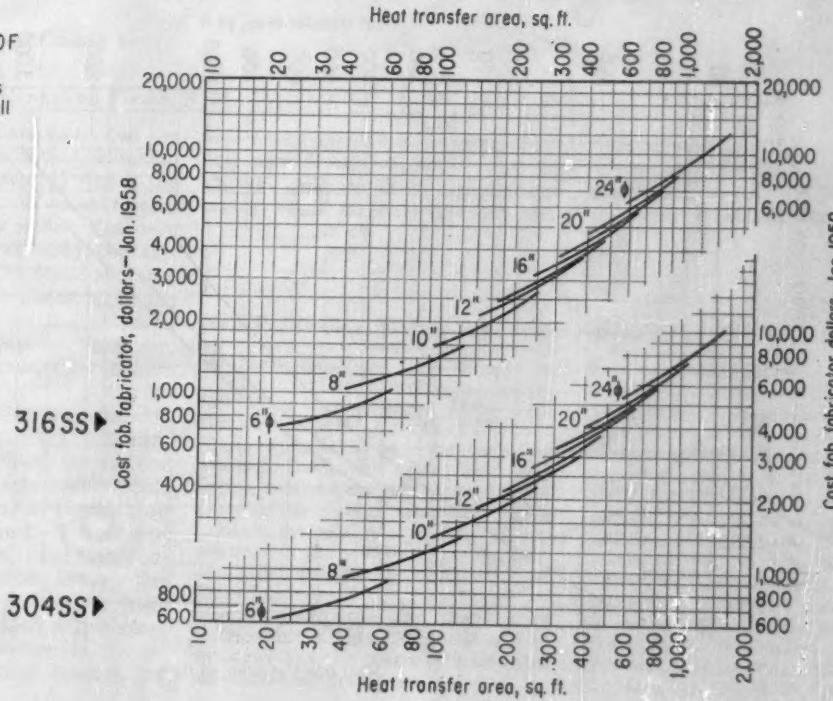
H. J. De Lamater, Chairman, AACE Heat Exchanger Cost Committee

Cost to fab. fabricator, dollars-Jan 1958



Vapor Condensers—Model "VT"—TEMA Class A

¾" OD x 18 BWG tubes
on 15½" Δ pitch
75 psi. shell & tube; 400F
Stainless steel tubes,
tube sheets & bonnets
Seamless steel pipe shell



Struthers Wells Fixed Tube Sheet Exchangers

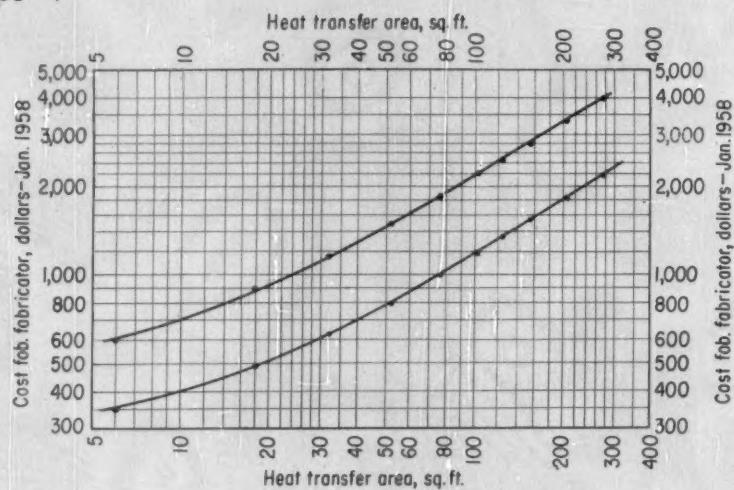
Vertical Condensers—Type "V"

304 Stainless steel

$\frac{3}{4}$ " OD x 18 BWG
25 psi. shell & tube; 300F
304 stainless top head,
tube sheets & receiver
Carbon steel shell

Admiralty or copper tubes

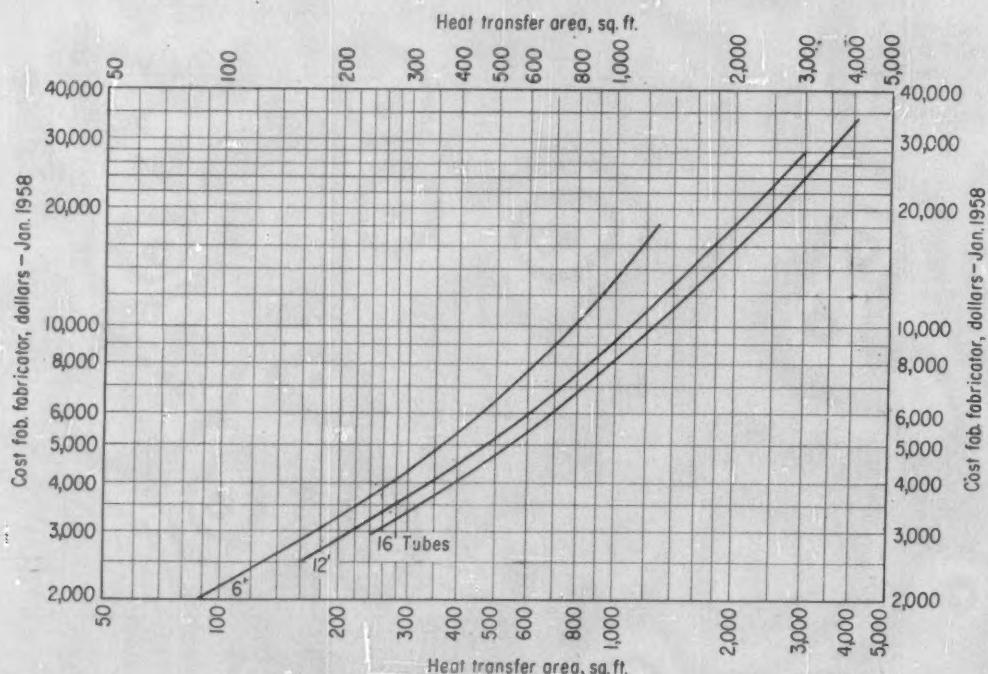
$\frac{3}{4}$ " OD x 16 BWG
25 psi. shell & tube; 300F
Carbon steel construction



Karbate-brand Floating Head Exchangers

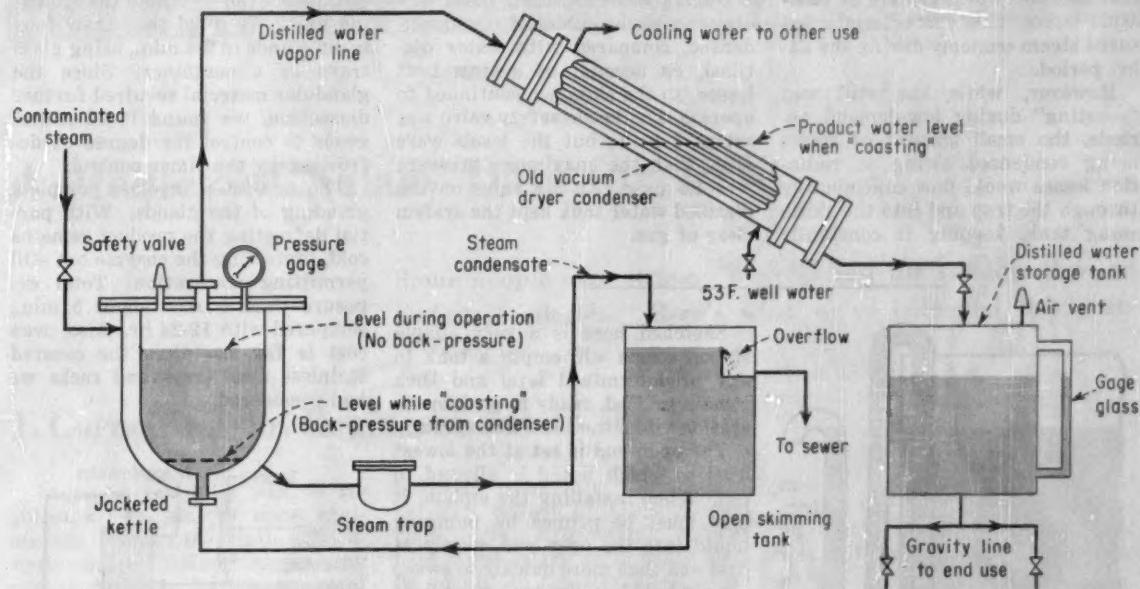
Karbate impervious graphite grade 22 tube bundles & covers

Single pass units
 $\frac{7}{8}$ " ID tubes
Steel shell & baffles
Removable tube bundle & full-floating head



PRACTICE . . .

PLANT NOTEBOOK EDITED BY T. R. OLIVE



Distilled water withdrawal rate controls still back-pressure and hence still water level and amount of water vaporized.

Water-Still Controls Itself Automatically

★ Winner of October Contest by
H. Leslie Bullock

Engineering Consultant, New York 6, N. Y.

A good many years ago I had the job of providing distilled water to an isolated plant section where the only water supply was an extremely hard and cold well water. The only steam available was badly contaminated. Our need for distilled water was variable throughout a 24-hr. production period so it had to be supplied more or less continuously, but at a variable rate, to a storage tank.

Condensing the stream directly was unsatisfactory owing to its contamination. Therefore, we decided to distill condensate from this steam, after passing it through an open skimming tank. The equipment used, shown in the sketch, consisted of a jacketed kettle, the skimming tank, a steam trap, condenser and distilled water storage tank, plus instruments.

The self-regulating feature of

this setup worked as follows: During periods of low water use the storage tank would fill and distilled water would back up into the con-

denser, masking some of the condenser surface. This in turn would create back pressure which would force water out of the kettle and

NEXT ISSUE: Watch for Announcement of November Winner

★ How Readers Can Win

\$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award \$50 each four weeks to the author of the best short article received during that period and accepted for Plant or Design Notebook.

Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

\$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional \$100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable non-winning articles will be published at space rates (\$10 min.).

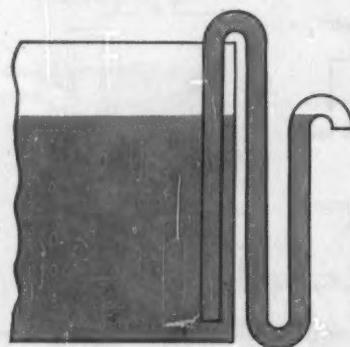
Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Design Notebooks, *Chemical Engineering*, 330 W. 42nd St., New York 36, N. Y.

into the skimming tank. With little or no water in the kettle, evaporation would substantially cease and steam consumption would drop to that necessary to take care of radiation losses. This characteristic assured steam economy during the 24-hr. period.

However, while the still was "coasting" during low-demand periods, the small amount of steam being condensed owing to radiation losses would flow continuously through the trap and into the skimming tank, keeping it constantly

clean and assuring a constant supply of hot water, ready to flow into the distillation kettle at any draw-off of distilled water.

During draw-off, also, there was always a slight excess of steam condensed, compared with water distilled, on account of system heat losses, so the skimmer continued to operate. The kettle safety valve was set at 4 psig., but the levels were such that the maximum pressure was 1.5 psig. An air valve on the distilled water tank kept the system clear of gas.



Simplified Siphon Also Holds Its Prime

C. F. A. Roberts
Superintendent,
Plant Investigations Dept.
Orr's Zinc White Ltd.
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Editor's Note—A recent Plant Notebook prize (Oct. 6, 1958, p. 153) went to Dr. Roberts for a two-speed, never-empty tank siphon which was the most ingenious invention in siphons to come to this editor's attention. Having been notified of his winning, Dr. Roberts wrote: "Your letter prompted me to think the problem through again from first principles—and I suddenly wondered what on earth I'd been playing at to devise so complicated a piece of equipment! In the Mark II siphon, I've greatly simplified the idea. Compared to Mark I, its only disadvantage is that it is somewhat slower for the same diameter of tubing."

When you have the problem of maintaining a tank level between given working limits, a siphon may be a good solution, especially if the tank is glass or rubber-lined.

Sketched here is a very simple siphon which will empty a tank to any predetermined level and then remain primed, ready to go into operation when the tank fills again.

The open end is set at the lowest level to which liquid is allowed to fall. When installing the siphon, it first must be primed by pumping liquid into the open end, slowly at first and then more quickly to sweep out air bubbles. The tank must have been filled to at least the level of the outer end before this can be left open. When any additional liquid is added to the tank, it will overflow until the tank level drops to that of the open end. However, although flow will then cease, the siphon will not break since air cannot get past the bend at the outlet.

Such a siphon can easily be rigged from a piece of hose suitably supported. The siphon's dimensions, of course, will depend on the size of the tank, the working level, and the rate of emptying desired.

Electronic Oven Defrosts Enzymatic Material

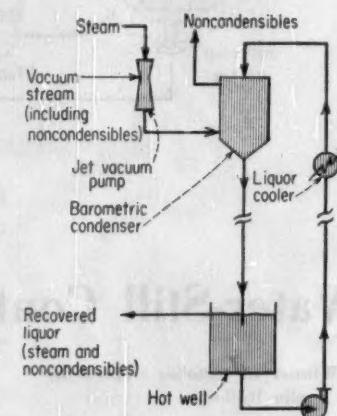
Norman L. Hobbs
Manager of Technical Service
Product Development Laboratory
Wyeth Institute for Medical Research
Philadelphia, Pa.

In one of our processes for extracting enzymatic material from animal glands we have found it necessary to keep the raw material frozen until 12 to 24 hr. before use. Formerly we would spread the frozen glands out on paper to thaw, 300 to 600 lb. at a time, requiring a very large thawing area and introducing the possibility of bacterial

contamination or the development by pyrogens.

To overcome these difficulties, we decided to try a domestic model of electronic oven—without the browning unit. We could then thaw four to six glands in 2-4 min., using glass trays as a container. Since the glandular material required further dissection, we found it advantageous to control the degree of defrosting by the timer control.

The final step involves complete grinding of the glands. With partial defrosting the product remains cold, protecting the enzyme but still permitting maceration. Total exposure time is now about 5 min., compared with 12-24 hr. Also, oven cost is far less than the covered stainless steel trays and racks we had considered.



Avoid Excess Dilution in Recovering Condensates

Jerome A. Seiner
Development Engineer
Paint Research Department
Pittsburgh Plate Glass Co.
Springdale, Pa.

In processes evacuated with steam jet pumps, byproduct materials are often lost due to extreme dilution in the barometric condenser. An example might be hydrochloric acid which normally would be neutralized in the hot well for disposal, thus involving neutralization expense and losing possibly valuable material.

The diagram shows how dilution can be avoided by using no fresh makeup water in the condenser, merely cooling and recycling the condensate.

PRACTICE . . .

YOU & YOUR JOB

EDITED BY R. F. FREMED

A Medley of Salary Data for 1958

Some people save string. We clip and file random data on technical salaries. Here's what we've collected this year.

1. Cornell's 5-Yr. Engineers Are in the Chips

As you know quite well, it requires a 5-yr. stay at some engineering colleges to obtain a bachelor's degree. Most engineering schools, however, have a course of study that lasts four years, with a summer session, or surveying camp or a between-semesters unit operations lab thrown in for good measure.

Does this fifth year of undergraduate work pay off? Or does the 5-yr. undergraduate suffer an economic disadvantage in the long run? Through the courtesy of Dr. C. C.

Winding, Director of Cornell University's School of Chemical and Metallurgical Engineering, we now have some salary data which may be applied to the formation of an answer for this question.

In Table I, below, salary figures are given for chemical engineering graduates of Cornell back through 1938. These men completed a 5-yr. undergraduate course. In addition to the tabulated salaries we have a somewhat more detailed analysis on the 1958 graduating class. Average starting salary was \$533/

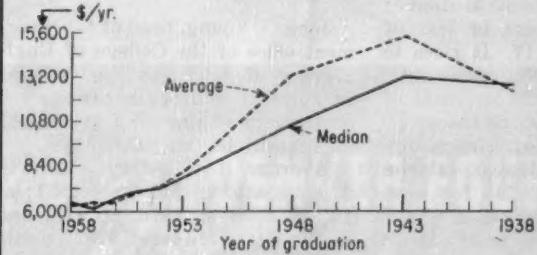
month; median, \$535/month. The median for the top half of the class was \$552; highest reported salary was \$575/month; and lowest was \$491.

These figures are for 29 men who supplied information. In a few instances, 1958 grads did not report salary information and a considerable number of the 1958 grads entered the Armed Forces and graduate schools.

When the data are plotted, some points of interest show up. Note that this year's graduates are being

Salaries of Chem. Eng. Graduates—Table I

Class Of	No. In Class	No. Of Replys	%	Avg., \$/Yr.	Median, \$/Yr.
1958.....	—	29	—	6,396	6,420
1957.....	40	26	65	6,360	6,336
1956.....	33	15	45	6,696	6,756
1955.....	29	14	48	7,204	7,240
1954.....	39	29	74	7,404	7,376
1953.....	31	23	74	7,920	7,716
1948.....	45	39	87	12,144	10,680
1943.....	32	22	69	15,264	13,200
1938.....	14	10	71	12,502	12,756



Breakdown of the Class of 1953—Table II

Major Field	No. Of Reports	Highest Salary, \$/Yr.	Avg. \$/Yr.	Median, \$/Yr.
Science.....	16	12,500	7,986	8,010
Engineering.....	109	10,068	7,057	7,450
Manufacturing.....	31	12,000	7,303	7,300
Labor Relations.....	10	8,400	7,017	7,175
Sales.....	47	12,000	6,925	6,780
Military Service.....	12	8,460	6,780	6,750
Utilities.....	9	8,628	6,696	6,600
Hotel and Restaurant.....	15	11,000	7,061	6,410
Insurance.....	11	10,360	5,392	6,400
Advertising, Public Rel. and Publishing.....	15	8,400	5,980	6,000
Federal Govt.....	7	6,900	5,784	5,980
Teaching.....	17	9,600	5,697	5,800
Banking and Finance.....	21	10,000	5,280	5,580
Agriculture.....	26	20,000	6,492	5,465
Law.....	25	8,300	5,205	5,250
Medicine.....	24	8,000	2,825	2,350

NOTE—Survey by the Cornell University Placement Service in July, 1958 to determine what careers graduates pursue and what progress they make. Of 1,400 questionnaires sent, 588 were returned (over 40%). However, this group may not represent the class as a whole.

hired in at rates that are more than those being paid to men who have been out of school for a year. What a salary administration headache this can cause.

Once again we see the plateau effect on salaries as people stay in the profession past the 10- or 15-yr. mark. And if you stay in engineering for as long as 20 years, your younger colleagues may be earning more than you.

Comparing the Cornell survey with other salary surveys is difficult because of the small number of salaries reported and because the data were supplied by employees rather than employers. Usually, employee surveys show higher salary curves because the missing replies belong to those who are ashamed of their salaries. The most successful and highest paid people are the first to respond.

In any event, this survey shows us that chemical engineers after completing five years at Cornell are doing quite well. They start high and show fast progress in earning power.

In Table II we've shown the results of a survey conducted by the Cornell University Placement Service on the Class of 1953. Mr. David M. Kopko, Asst. Director of the service, agreed reluctantly to allow us to reproduce this information because he was dissatisfied with the number of returns. Of the 1,400 questionnaires sent, only 556 were returned in time to be included in the statistics. Because of this, Kopko suggests that the survey may not represent the entire class.

Our chemical engineers (comparing Tables I and II) seem to be doing better than the engineering graduates as a group. The only median salary that is higher than engineering is that reported for science graduates. However, most of the 16 scientists who replied must be outstanding individuals. Notice the guy who after only 5 years is earning \$12,500/yr. Farming may not be such a bad racket, if you have connections. The reported income of \$20,000 is very appealing. But the doctors of medicine take it on the chin (or in the wallet, if you prefer). After five years they are still struggling to earn enough to live on, reporting a median income of only \$2,350/yr.

Chemical engineering at Cornell does pay, even if it takes 5 years to get a B. S. degree.

2. Ceramic Engineers

The National Institute of Ceramic Engineers has just completed a salary survey of all members of their national society and the parent organization, the American Ceramic Society.

Tabulated below are the median incomes reported by members of the American Ceramic Society arranged by the number of years since receiving the bachelor's degree:

No. of Years	Median Annual Income, \$
0-4	6,200
5-9	8,000
10-14	9,000
15-19	10,800
20-24	11,900
25-29	12,600
30-34	13,000
35-39	14,000
40 or more	14,000

Median salary for all members of the society is \$10,000 compared to \$8,000 in 1953. Median salary for the ceramic engineers as a group is \$12,000 in 1958 compared to \$8,800 in 1953.

Apparently a ceramic engineer is to a ceramist what a chemical engineer is to a chemist.

3. Experimental Biology

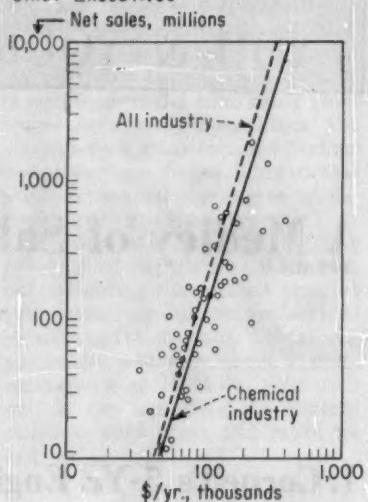
If only I could have seen clearly through a microscope, I might have majored in biology instead of chemistry in high school. Does this apply to you also? If so, you'll be interested in the survey completed this past summer by the Federation of American Societies for Experimental Biology.

Survey was made on 9,237 experimental biologists who returned questionnaires. Of these 58% hold Ph. D. degrees, 33% M. D. degrees and 9% had at least two doctoral degrees.

Median 1958 salary for the entire group was \$8,405 but rose steadily with experience. Median of those with four years or less of experience was \$6,117. It rises to \$11,774 for the 1,000 experimental biologists with 28 yrs. or more of professional work behind them.

As in other fields of science, universities pay the lowest salaries with a spread of \$2,244 for newcomers in the profession to \$8,000 for those who have practiced 28 yrs. or more.

Total Compensation of Chief Executives



4. Top Brass Pay

Indirectly, your salary is fixed by the amount of money that the president of your company earns. For example, if the president of a large corporation earns \$100,000/yr., then the vice president may get to the \$50,000/yr. level.

That would put the chief engineer at about \$35,000 and all other engineering salaries would be scaled down from there. Therefore, you ought to be extremely interested in the total compensation paid to the top man in your organization.

Harvard Business Review conducts such a survey each year. They correlate total compensation of the chief executive as a function of the net sales of the business. Since the latest sales figures are to the end of 1957 only, this 1958 survey reports 1957 salaries. The chart above shows how chemical industry top executives compare with all of industry.

They do better than average.

5. Michigan's New Grads

John G. Young, head of the placement office of the College of Engineering at Michigan reports that in spite of a drop in campus recruiting of engineering graduates, all found jobs this year.

Average B. S. salary offer was \$480/month, up \$15 from 1957; at the M. S. level, \$570, up \$18; and at the Doctorate level, \$732/month, up \$52.

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For Effective Propeller Agitation in Tanks as Large as 50' Diameter

Design of DENVER turbine type propeller makes possible large diameter propeller agitators for agitating large volumes of pulp in large tanks. One large diameter agitator handles volume of several small ones—saves space, operating expense, supervision, maintenance.

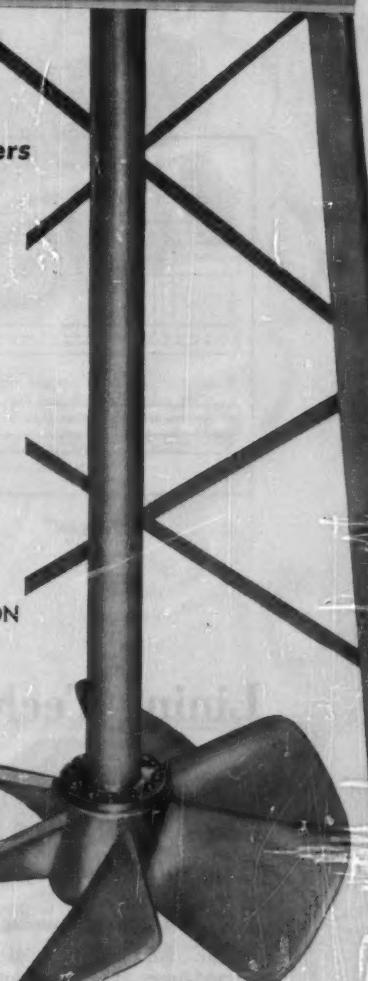
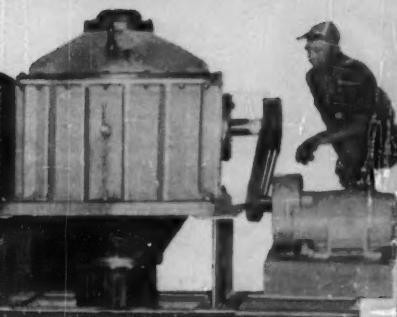
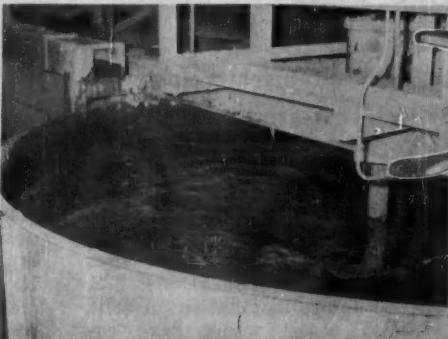
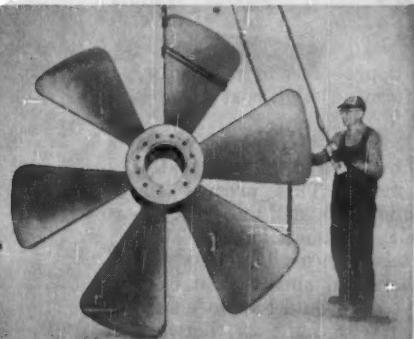
- Large diameter propeller operating at low speeds gives proper agitation with heavy slurries even as coarse as 10 mesh. Slower speeds mean savings in horsepower and further savings from reduced wear.
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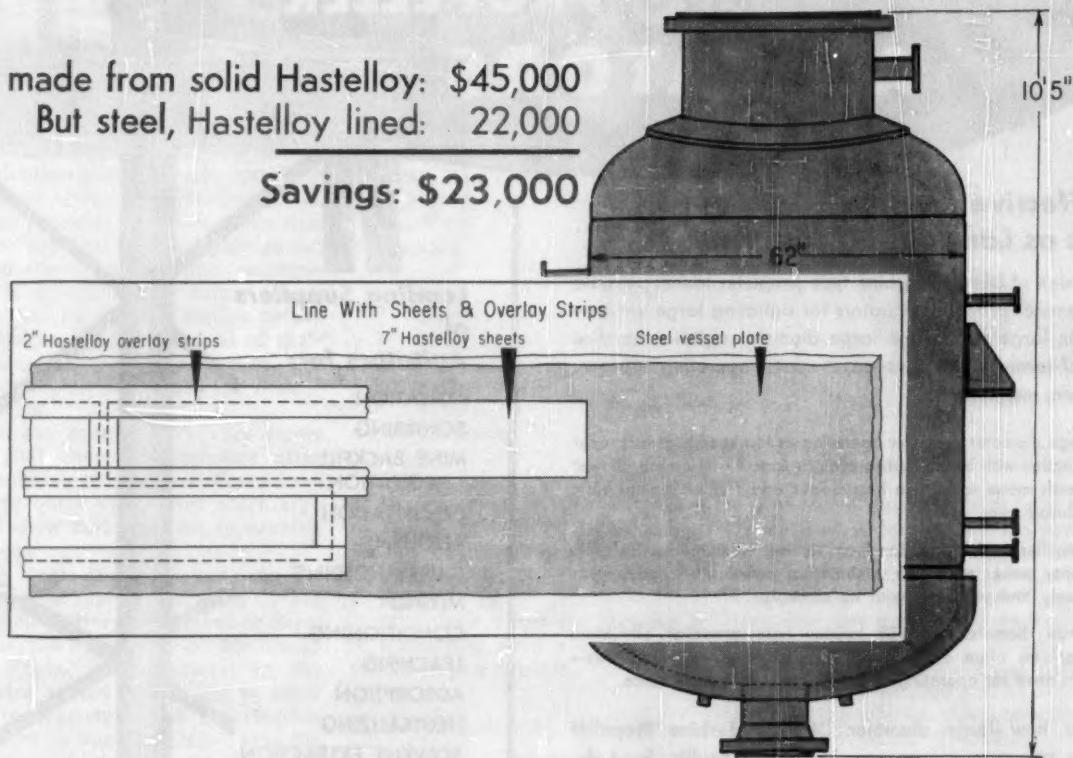
PRACTICE ...

CORROSION FORUM

EDITED BY R. B. NORDEN

If made from solid Hastelloy: \$45,000
But steel, Hastelloy lined: 22,000

Savings: \$23,000



Lining Technique Halves Vessel Cost

Consider lining with hard-to-fabricate Hastelloy.

Large vessels can be lined by welding; are much cheaper than solid-alloy equipment.

J. F. De Lorenzo, Manning & Lewis Engineering Co., Newark, N. J.

For corrosive service, it's surprising that alloy-metal-lined equipment is not called for more often in chemical and petroleum plant designs. Such equipment will usually perform as well as solid alloy vessels. And a lined tank or reactor is much lower in cost, particularly if the alloy is expensive and difficult to fabricate.

► **Big Lining Job**—For example, we have just completed one of the largest lining jobs yet done with Hastelloy alloy B. The

10-ft. 5-in. high by 5-ft. 2-in. O.D. (carbon-steel shell) pressure reactor (*above*) cost \$22,000 before installation. A solid-alloy vessel would have cost around \$45,000.*

Of course certain precautions have to be taken when applying the lining—which involves welding liner strips to the carbon steel vessel, sealing seams and welding overlay strips. But this technique avoids all the

* Estimated cost of a solid carbon-steel vessel: \$6,000.

difficult problems of machining and forming high-cost Hastelloy B.

Still another approach would have been used of integrally-clad metal. This process for Hastelloy B is still under development, although such a cladding has been used successfully in heads and shells. Cost of a clad vessel would have been approximately halfway between our lined vessel and one made from solid alloy.

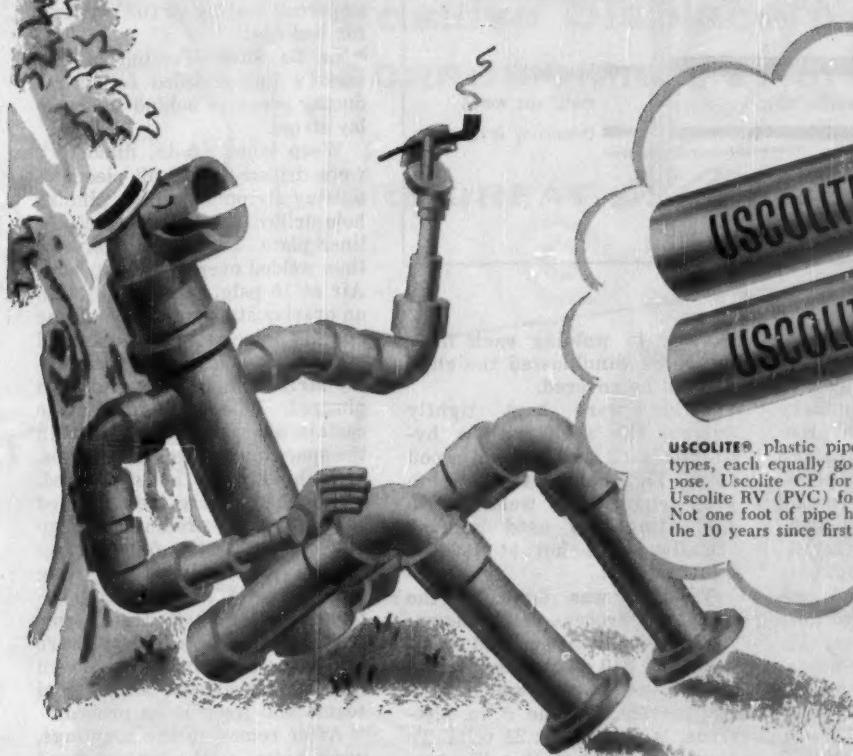
The final lined vessel (all inlet and outlet openings were also lined) is in use at the Atzcapotzalco petroleum refinery in Mexico. It is a pressure reactor for an isomerization unit, handling boiling HCl. Design adhered to the ASME



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USCOLITE® plastic pipe comes in two specific types, each equally good for its particular purpose. Uscolite CP for high impact resistance, Uscolite RV (PVC) for active oxidizing agents. Not one foot of pipe has had to be replaced in the 10 years since first installed.



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Mechanical Goods Division



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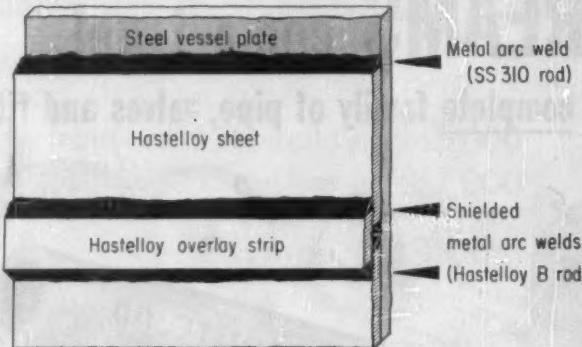
Rockefeller Center, New York 20, N.Y.

In Canada: Dominion Rubber Company, Ltd.

*Patent applied for

When you think of plastic, think of your distributor. He's your best on-the-spot source of technical aid, quick delivery and supply of plastic pipe and fittings.

Proper Welding: Key to Lining Technique



Boiler and Pressure Vessel Code, section VIII, for corrosive service at 350 psi. and 450 F.

► **How It's Done**—Preliminary steps in the construction process involve cutting to size and forming all carbon steel parts. The lining material (nickel 61%, molybdenum 26 to 30%, iron 4 to 7%, cobalt 2.50%, chromium 1.00%, manganese 1.00%, silicon 1.00% and carbon 0.05%), was also cut into plates and formed whenever this could be done preceding actual fabrication. Our technique called for lining the shell section with 8 courses of $\frac{1}{4}$ -in. thick by 7-in. wide Hastelloy B sheet. Each course contains 4 pieces, 7-in. wide by 46 $\frac{1}{2}$ -in. long, put in transversely one at a time.

J. F. DeLORENZO received his BS degree in mechanical engineering from Louisiana State Univ. in 1943, and has done graduate work at Columbia in N. Y. Following military service from 1943 to 1946 in the Corps of Engineers, U.S. Army, he joined the design engineering staff of Manning & Lewis Engineering Co., Newark, N. J. His experience there has included all phases of design and estimating of heat exchangers and pressure vessels used by the petroleum and chemical process industries. In 1953 Mr. DeLorenzo was named Chief Engineer of Manning & Lewis.

Prior to welding each liner piece, we sandblasted the shell area to be covered.

Strips were kept tightly against the shell with a hydraulic jack and a hard wood form. This helped to dissipate heat generated by welding. No preheating was used because the alloy is hot-short at elevated temperatures.

Welding was done by the metal-arc process in the down-hand position with coated stainless steel 310 electrodes for the carbon steel to alloy welds. Normal current, for the $\frac{1}{8}$ in. electrode, is 90 amp. at 25 volts. To keep heat effect on the alloy to a minimum, we directed the electrode almost entirely on the steel with the edge of the arc making contact with the liner. A single bead was used and laid in at the most constant speed possible for non-automatic welding. To avoid locked-in stresses, we welded one short and one long edge of the liner and allowed this to cool before welding the other two edges.

► **Head More Complicated**—Understandably, the procedure for lining the elliptical head is more complicated. Positioned concave side up, the elliptical head was surmounted by a pipe tripod, with tripod legs clamped to the straight flange. The apex served as the pivot point for the hydraulic jack that exerted pressure on the hard-wood forms used to position and form liner pieces. Welding technique: identical to that used on the shell.

Spaces between adjacent liner sections were covered by 2-in. wide strips of 14-gage Hastelloy B—welded to the alloy lining using the inert-gas metal arc-welding process, with $\frac{1}{8}$ -in. diameter bare wire as filler metal. Channels under the overlay strips are continuous throughout the vessel to permit testing of the overlays for leakage.

► **To Be Sure**—Testing of the vessel's lining called for introducing pressure behind the overlay strips.

Weep holes ($\frac{1}{8}$ -in. diameter) were drilled behind all pieces of overlay stripping, with a similar hole drilled behind each piece of liner plate. Pipe couplings were then welded over each weep hole. Air at 15 psig. came in through an overlay strip weep hole at one end of the vessel. We checked all other weep holes under the overlay strips for air flow and then plugged. This procedure made certain air was flowing through the space under all overlay strips.

With all weep holes plugged, inside seams were then checked for leakage by preliminary soap and water tests, followed by highly sensitive tests using Freon and a halogen leak detector. These showed all seams free from leakage. Plugs were removed and an internal halogen test performed with all external seams and weep holes probed.

After removing the couplings, weep holes in the bottom head were plug welded. And after installing the bottom head jacket, entire unit was subjected to final hydrostatic testing (525 psig. in the shell and 115 psig. in the jacket).

Cooling-Tower Problem Licked

A modified epoxy coating, designed to protect wood cooling towers, is causing quite a stir among design engineers.

The developer—A. R. Moberg Laboratories, Inc., Los Angeles, Calif.—claims their coating* provides a means for prolonging the life of cooling towers indefinitely. It eliminates problems of wood delignification, chlorine attack, white and brown dry rot.

Up to now the best available

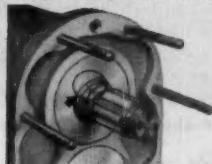
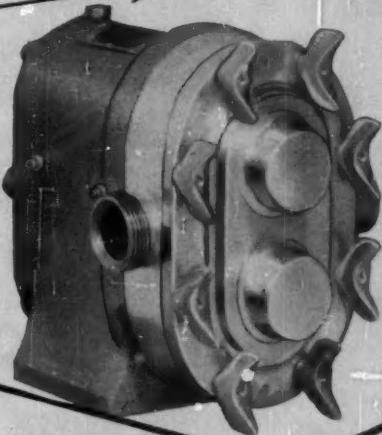
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Positive Displacement
CORROSION-RESISTANT PUMPS

ARE GREAT *tranquilizers*

Positive Displacement



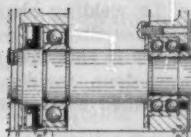
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Stated in capsule form — when you equip your plant with WAUKESHA PUMPS you can be tranquil about pumping problems. WAUKESHA PUMPS live long trouble-free lives — for they are engineered and BUILT with great reserves in ruggedness and operation in excess of usual pump design. Check the features shown here. They tell the story.

And WAUKESHA PUMPS "tranquillize" your product flow. No turbulence. No product breakdown. No noticeable pulsation. Heavy, viscous fluids, products with large, discrete particles are no more a problem than products of low specific gravity. Get tranquility now with WAUKESHA.

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CORROSION FORUM . . .

technique for controlling these effects was by maintaining a proper pH in the cooling water. This was never completely satisfactory.

Fluor Products Co., Whittier, Calif., has exclusive rights to apply the coating in the field. Also, Fluor will coat wood on all their new cooling towers before erection.

One big advantage: special resins and catalysts permit use

of the epoxy coating on wet or dry wood surfaces. This claim is backed up by extensive laboratory testing. So it's not necessary to take a tower completely out of service before applying the coating.

Present planning calls for a two mil coat on new tower units. Fluor will do this on a production-line basis, then ship the components to the jobsite for erection. The outside tower

sheathing could also be sprayed to prevent any leakage or seepage. A two mil coat appears sufficient for 10 to 15 years protection.

For existing towers the coating would be applied one cell at a time to minimize down time. A full tower coating could be completed in one to three days.

Procedure would go something like this: the first cell to be coated would be taken off stream, hosed down, and allowed to drip and dry from one to three hours. Then components would be spray coated. A second coat, if required can be put on one hour after the first. The cell would be back on stream four to five hours after the initial coat. But the resin will continue to cure under water.

In addition to the advantages mentioned, there are some other good points:

- Coating will cost about the same as pressure impregnating pretreated wood with a germicidal material, while giving better protection.

- Coating is fire retardant.

- There is no loss in wood strength.

- It does not leach or dissolve in water.

- Coated wood allows much wider latitude in chemically treating circulating water. Water treatment can now be designed to control corrosion in the heat exchange equipment. Previously some compromise had to be reached since wood deterioration limits the choice of inhibitors.



Crest Instrument Co.

Corrosion Meters: Quick Way to Optimum Inhibitor

Since their introduction (Chem. Eng., Jan. 1957, p. 156) corrosion meters have rapidly moved into chemical and petroleum plants, where the portable models are particularly useful in field testing.

Inhibitor evaluation is one area where the meters are proving their worth. Here they quickly establish optimum inhibitor concentrations under ac-

tual process conditions. Previously metal coupons would be suspended in the process stream, removed periodically and checked for weight loss. This is a long, drawn-out procedure.

The meter measures electric resistance of two probes, one exposed to the corrodent, the other protected by plastic or ceramic; gives a quick reading without removing the probes.

Now: Tantalum-Lined Equipment

Another example of an unusual lining job comes from The Pfaudler Co. and Haynes Stellite.

Pfaudler has lined a 30 gal. vessel with 0.030-in. thick tantalum sheet. Two recent developments make this possible: availability of large tantalum sheets and improved Ta welding characteristics (Haynes Stellite has done a lot of work in this area).

Welding was done inside a special chamber filled with inert gas.

The vessel's base metal is Type 430 stainless. It also has a solid tantalum agitator; is designed for 650 F., 500 psi.



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Two types of USS National PVC Pipe are available:
Normal Impact—for installations requiring the highest chemical resistance attainable, together with high strength and excellent creep resistance.

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USS National PVC Pipe comes in sizes from $\frac{1}{2}$ inch

to 14 inches in diameter, and in Schedules A, 40, 80 and 120.

If you'd like more information, write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa. Ask for Bulletin No. 24.

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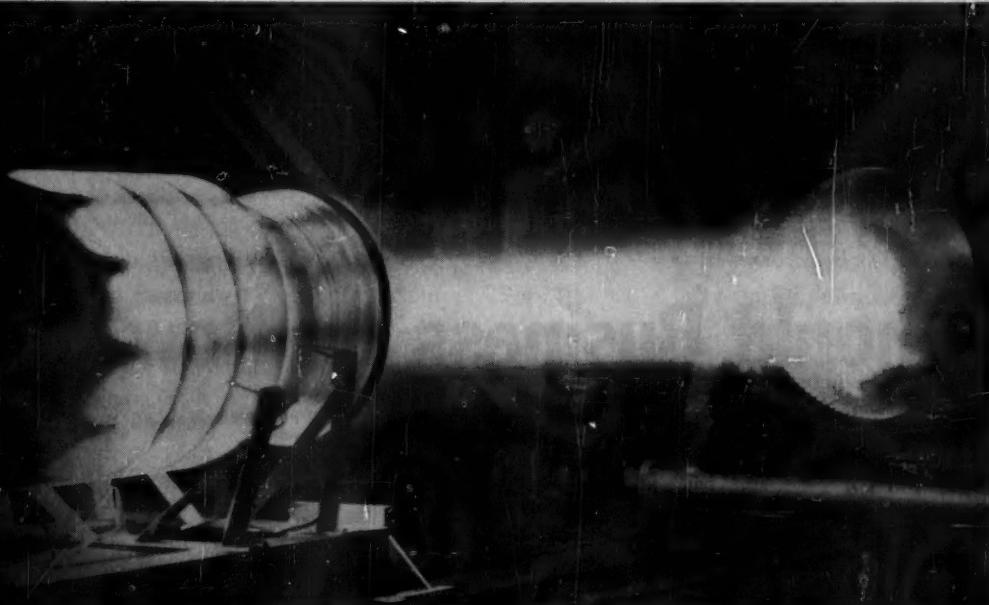


Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors

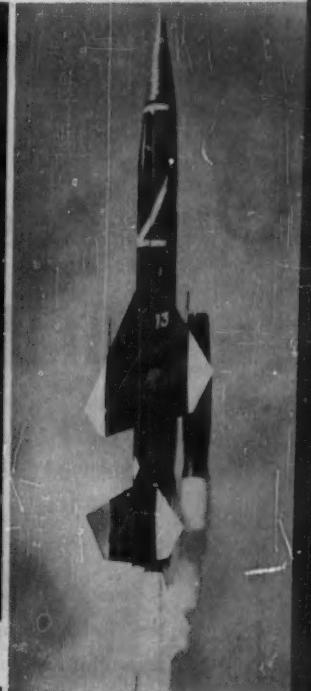
United States Steel Export Company, New York

MARQUARDT NOW NEEDS ENGINEERS AND TECHNICIANS

for New Ramjet Test Facility at Ogden, Utah



The ramjet engine being production tested here provides cruise power for the BOMARC, one of America's fastest, most advanced public defense weapons.



This may be the opportunity you've always wanted. Marquardt is now completing a new facility for production test of ramjet engines for the accelerating BOMARC program. Hiring of engineers and technicians to operate this facility is now starting.

The new test facility is a companion to Marquardt's Ogden manufacturing plant. This plant is in volume production on the ramjets which provide supersonic cruise power for the BOMARC.

The test facility, to be one of the most powerful of its kind in the country, will provide for sea level to high altitude testing of supersonic ramjet engines with the most advanced mechanical and electronic equipment.

Opportunities for individual contributions are stimulating and abundant. This is also true of advancement possibilities. Not only will your job be as big as you want to make it, but you'll be stepping up to an enviable western life. Hunting, fishing, fast ski slopes and all other sports are minutes away. Clear, dry mountain air will make you forget smoky, smoggy, foggy skies, and muggy days.

Your opportunity is waiting. Hiring is starting now and will accelerate through most of 1959. Why not write for Marquardt's factual booklet—so that you can learn more about the opportunities available? Send a letter or card now—before you forget.

For informative booklet: Write Dick Hermann, Facilities Manager, Marquardt Aircraft Co., 3000 West 33rd Street, Ogden, Utah.

Many good positions now available!

- Control System Engineers
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In financial aid to education . . .

What Should Business Do Now?

Now that the federal government is entering the field, should business firms stop giving financial aid to our colleges and universities?

This question is now being discussed by business directors throughout the country. The discussion is prompted by the near-billion-dollar program of federal aid to education passed by Congress a few months ago. For if the federal government, with its access to billions in taxes, is assuming responsibility for the financial welfare of education, should not business get out of the way and let the government take over? This is the general way the question is being asked.

The answer is a resounding NO.

What The Federal Program Does

The new federal program makes it possible for the government to spend the imposing total of \$900 million for aid to education over the next four years. There are still many loose ends in the program. But already it's quite clear what such funds will — and will not — do to help relieve the financial plight of our colleges and universities.

First of all, the program is not going to solve any financial problems in education overnight.

The program is just barely underway. So far no money has actually been allocated, and Congress has appropriated only \$40 million — less than 5% of the total.

More important, there is very little in the total program which will result in direct aid to colleges and universities. The program does set up fellowships to train college teachers. But most of the aid will eventually be channeled through the states to primary and secondary schools. The main focus of the program is education for national defense — strengthening science, mathematics and foreign languages in elementary and secondary schools, together with grants for counseling, testing and research.

The one big item for higher education is a \$295 million student loan program, which will help needy students pay tuition and other fees. But tuition rarely covers the full cost to the college of educating a student. So the net result could well be an additional financial strain on our institutions of higher learning.

For the three most pressing financial needs — faculty salaries, scholarship grants and new plant and equipment—colleges and universities must still rely heavily on help from the business community. And it would indeed be a major

misfortune if the recent actions of the government put a blight on this growing and substantial support to higher education.

In the last ten years, business has expanded its financial aid to education by more than four fold. In 1948, contributions were only \$24 million. In 1957, such aid reached an estimated \$125 million. Moreover, corporations have been putting a larger proportion of their total charitable gifts into education. In 1950, the percentage was only 17%. By pre-Sputnik 1956, the share had already increased to 34%, according to figures recently released by the Council for Financial Aid to Education.

Why Business Must Help

The most compelling reason for increasing business aid to higher education — at an even faster rate—is that our colleges and universities desperately need financial help. It is that simple. Private contributions to higher education must average at least \$400 million over the next ten years if our colleges are to meet rising operating costs and raise faculty salaries to decent levels. Despite the growth in business contributions, we are still well below that goal.

If our colleges cannot solve their mounting financial difficulties through voluntary help from business firms, alumni and communities — then it is to be expected that federal aid ultimately will be mobilized in a big way. In principle, if not in dollars, the 85th Congress has paved the way. Indeed, a large federal scholarship program was squeezed out of this year's legislation only in the course of last-minute compromises. And Arthur S. Flemming, Secretary of Health, Education and Welfare, has urged that the next session of Congress restore the scholarship program.

About any federal rescue operation for higher education, two things are quite clear:

- (1) Such aid will come too late to prevent irreparable harm resulting from the current shortage of funds. The need for help is urgent and immediate.

- (2) With federal taxes taking over half of all corporate income, any federal program in the end will be financed in large part by the business community.

An Opportunity

So, viewed narrowly, it is in the selfish interest of business firms to aid our colleges and universities now, rather than wait and be forced to pay later on. By doing so, they ensure that business will have a continuing supply of well-trained graduates. They take advantage of the tax laws for charitable contributions which mean the government in effect assumes more than half the cost of business aid to education. And they win gratitude for a voluntary and generous act.

Viewed in the broad public interest, the business community has an opportunity to perform a financial rescue mission in education which could well be the key to successful survival, not only of our present system of higher education, but also of the nation itself.

As previous editorials in this series have pointed out, a very small share of the net income of business firms — about 1% — would do the job. Certainly business must not be distracted from this opportunity by the new venture of the federal government in financial aid to education.

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Published in the interest of better processing by Sprout, Waldron & Co., Inc., Muncy, Penna.

BULK TRAILER FOR NEW JERSEY FLOUR MILLS

Delivery of a modern 1,225 cu. ft. capacity bulk body pneumatic flour handling trailer to New Jersey Flour Mills Company, Clifton, New Jersey highlights the trend to bulk handling in this industry.

The streamlined 28' bulk truck body is of single compartment construction, having seven 24"x24" inlet doors. Twin screw conveyors in the bottom of the body are driven through a positive infinite variable speed control unit. The system is self-contained and designed for efficient and economical loading and unloading at high speeds.

Lawrence F. Orbe, Jr., President of New Jersey Flour Mills Com-



28' Sprout-Waldron pneumatic bulk flour truck designed to speed local deliveries.

pany, stated that, "bulk flour is better flour; not only from the standpoint of product cleanliness and good housekeeping, but in its improved baking qualities as well; a fact proved by leading cereal chemists. Economies to the baking

industry through the use of bulk flour are also substantial. It is entirely possible that a savings of 30 to 40c/cwt. will develop through this modern method of loading out and transporting flour from mill to bakery."

SW

NICKEL MIXER FOR THERMOPLASTICS

The mixing of thermoplastic materials and formulations at The Dow Chemical Company, Midland, Michigan, requires the use of a special Sprout-Waldron Adaptoned horizontal batch mixer. Two unusual design requirements stand out.

In the first place, all parts in contact with the material to be processed were specified in nickel, and in the second place the mixer had to be jacketed for 30 psi liquid working pressure.

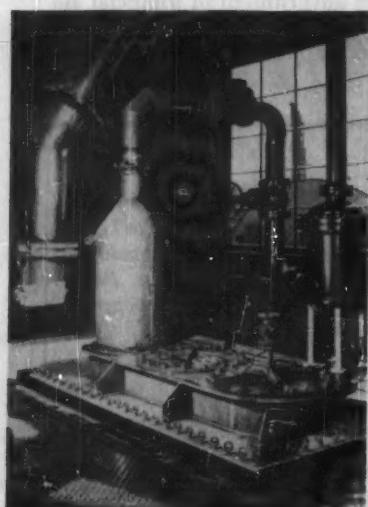
The Sprout-Waldron special horizontal batch mixer used, has a swept volume capacity of approximately 58 cu. ft. and is designed to handle a 3000# batch of material

weighing 50 lb. per cubic foot. Specifications also called for the mixer to have an extra heavy reinforced "U" trough and cover. The ASME code jacket was designed with internal baffles to prevent short circuiting and the box and cover of the unit were designed for 27" of mercury vacuum inside.

Mixing is accomplished by means of a double ribbon agitator with the end stubs set in antifriction pillow blocks.

Prior to shipment, the mixer body was tested at 30 psig with atmospheric pressure in the jacket. The jacket itself was tested at 45 psig with atmospheric pressure in the shell.

CP/110



Adaptoned Sprout-Waldron Horizontal Batch Mixer installed at The Dow Chemical Company, Midland, Michigan.

Chemical Engineering

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McGRAW-HILL PUBLISHING COMPANY, INC., NEW YORK CITY

Volume 65

January to December 1958

GENERAL ALPHABETICAL INDEX

Absorption:
Balloons pace gas velocity. Lyndon
Brock (P.N.) May 24 *148
For mass transfer—quick method finds
optimum trays and reflux ratio.
John Happel July 14 144
Mass transfer operations. J. O. Osburn
Mar. 24 145
Mechanics of mass transfer. Apr. 21 *161
How to use mass transfer coefficients
May 19 169
How to modify mass transfer equa-
tions June 16 182
Find number of theoretical stages
July 14 147
Transfer unit simplifies calculations
Aug. 11 147
Mass transfer behavior in fixed beds
Sept. 8 148
Correlate mass transfer coefficients
Oct. 6 146
Estimate efficiency in mass transfer
Dec. 1 119
Novel reoxidation scores nitrile acid
gains (N) July 28 58
Texas Butadiene & Chemical's plant
welds butylene isomers (N) July 14 84
U. S. Steel's nitrile plant optimized at
low cost (N) May 26 56
Accounting—How to deal with costs of
joint products and by products. Der-
showitz & McEntee Dec. 29 61
Acetylene - Methylacetylene - propadiene
commercially available May 19 76
Adhesives.
Bark extract, HT-120, intermediate
agent in formulation of plywood
bonding agent Sept. 8 76
Bond for vinyl and nylon or Dacron
fabrics Apr. 21 76
Foamed adhesives claim big plywood
economics (N) Dec. 21 66
"Glass-sandwich" resin can join metals
Stasys Masiliukas (P.N.) Aug. 11 152
Granular form hot melt adhesives
July 14 152
Mortar for shielding walls resists
radiation Apr. 21 76
Nonflammable strong bonding cement
Oct. 6 *68
Phenolic resin gives nitrile adhesives
improved tensile strength Dec. 29 36
Three synthetic-rubber, phenolic-resin-
base adhesives Nov. 3 70
Adipic acid — Monsanto Chemical Co.'s
new plant at Luling, La. on stream
(N) Jan. 27 *72
Adsorption.
Costs of solvent recovery systems.
Barney & Davis (charts) Dec. 29 *51
Dry adsorbers now open new sources
of gasoline—hydrocarbon recovery
from natural gas (N) Dec. 15 73
Molecular sieves—sharp, selective ad-
sorption pays off (N) Oct. 20 68
Molecular sieves with higher-octane
gasoline at Texaco Co. (N) Oct. 20 76
Moving beds double ion exchange cap-
acity at Lucky Mc Uranium Corp.'s
Riverton, Wyo. mill (N) Sept. 22 *80
Aerosols—N₂-propelled aerosols Jan. 13 *94

Agitation:
Current costs of vessels and motor
reducers—CE Cost File—IV. Harold
Gushin Sept. 8 141
Fluid mixing in tankcars. R. L.
Hates Aug. 25 *136
Operation and maintenance—Improve
adjusted performance. H. W. Dutson
Jr. & Others June 16 *172
Agricultural chemicals—Chemical trans-
quillizer for plants May 6 *68
Air Conditioning:
Alt. turbines ups gas-engine per-
formance Sept. 8 *80
Portable cooler slashes maintenance
costs July 28 *78
Alcohol:
Fatty-acids alcohols Oct. 8 70
Solvent blues: it's not just the re-
cession Aug. 11 90
Alumina-Ormet Corp.'s new alumina
plant goes into full production (N)
Aug. 25 *62
Aluminum:
Aluminum-covered storage building
Sept. 8 *154
Aluminum grains Aug. 25 *74
Aluminum paint June 30 66
Brighter atomic future for aluminum
alloys? Nov. 3 154
Foamed aluminum: looks like shiny
sponge cake (N) June 30 86
Low-cost heat exchanger with expend-
able aluminum (N) Apr. 7 108
New alloy available Sept. 8 156
Ormet Corp. massive Al-reduction
plant swings oil stream (N) July 14 *86
Two new aluminum alloys June 30 128
Aluminum silicate—Emulsifying agent
Nov. 3 *72
American Institute of Chemical Engi-
neers—Happy birthday A.I.C.E! June 2 *111
Ammonia:
Canadian Industries Ltd. new ammonia
plant uses fuel oil feed (N) Apr. 21 68
Find gas velocity by ammonia injec-
tion. R. L. Johnson (P.N.) Dec. 1 126
Hydrazine via NH₃ today—flowsheet
July 14 *120
Novel reoxidation scores nitrile acid
gains (N) July 28 *53
Plenty of boom left in ammonia. Sept. 8 72
Ammonium nitrate — American Cyan-
amid completes New Castle, Pa.
plant (N) Oct. 20 72
Ammonium sulfate — Flash oxidation
slashes metallic oxide costs (N)
Dec. 15 *78
Aniline — American Cyanamid's new
aniline plant uses catalytic hydro-
genation (N) May 19 *66
Anti-aquionone — American Cyanamid's
new unit to use direct oxidation
(N) June 16 70
Aromatics:
More aromatics from petroleum
(tables) May 6 78
Perfume process-studied plants key
to fragrances—flowsheet Feb. 24 *112
Trimellitic anhydride Dec. 15 92

Aryl mercaptans — Pitt-Consol Chemi-
cal's refining, not synthesis, may
zoom output Mar. 10 *83
Asbestos—Cyclone winnows asbestos
fibers from dust (N) Dec. 15 *82

Asphalt:
Anti-striping agent adds to asphalt's
weather resistance Mar. 24 *76
Ashland Oil & Refining's new vacuum
unit turns out asphalt, cracking
feed (N) Sept. 8 *70

Atomic Power:
Argonne National Laboratory nuclear
fuels center to tame reactor pluto-
nium (N) Feb. 16 *70
Atomic amplifier may ease highway
worries (N) Aug. 25 *82
Atomic power can lower regional fuel
costs Aug. 25 *72
Atomic waste hazard cut by fluid-bed
calcining (N) Nov. 17 76
Britain's Sceptre III (N) Apr. 1 *68
Charts give you percent conversion in
each reactor stage. T. M. Jenney
May 18 166

Chemical Engineering Achievement
14th biennial Award honors atomic-
metals pioneers (N) Jan. 18 *24
Construction and design studies for
nuclear reactors (N) Dec. 27 27

Core lowered in at Shippingport (N)
Jan. 15 *82

Cue for atom-fuel processing by in-
dustry? J. A. Klinz Oct. 6 *82

Fabrication job for sodium-cooled re-
actor poses design problems (N)
June 2 *66

Fast-breeder reactor fuel contracts let
for Enrico Fermi Atomic Power
Plant (N) Aug. 25 62

Flexible process tactics capture nuclear
fuel produced at Davison Chemical Erwin,
Tenn. plant (N) Apr. 21 62

GE to design and build nuclear power
plant for Italy's S.E.N.N. Nov. 17 82

Geneva experiences, guide to future
meetings (N) Dec. 1 70

High-dux reactor goes critical at Oak
Ridge (N) May 19 72

Inventory of new materials and tech-
nology May 5 135

New facility helps predict reactor-core
behavior (N) Nov. 3 *64

New steps taken toward taming fusion
reaction (N) June 16 70

Nuclear fuel costs? Nobody's sure
Dec. 1 72

Nuclear fuels, ceramics get a plant
and patents (N) Sept. 22 72

Nuclear industry—1958-1968 Apr. 7 90

Nuclear power future. C. G. Manly
(charts & tables) Mar. 10 *128

Nuclear testing moves into private
hands (N) Dec. 1 *68

Perhapstron and Zeta pioneer fusion
frontiers (N) Feb. 24 *70

Progress: research, building boom
(N) Sept. 3 33

Rotary-kiln reactor uses powdered
graphite (N) June 2 60

3 materials vie for role as reactor cool-
ant—flowsheet June 26 *90

NOTES—(D.N.) Design Notebook; *Illustrated; (N) News; (P.N.) Plant Notebook

Zirconium is more popular than ever for nuclear reactors..... Nov. 17 174
 Award—Chemical Engineering Achievement 14th biennial Award honors atomic-metals pioneers (N) Jan. 18 *24
 Azelaic acid Feb. 21 *78

B

Barium oxide—Barium Reduction Co.'s lower process temperature ups BaO quality (N) Oct. 6 *56
Batch Operations:
 Cold trap cuts vacuum cycle time Jan. 27 *80
 Operation and maintenance—Continuous and batch filters. G. G. Reid June 16 *160
 Benzene—Humble Oil & Refining's new benzene unit marks petrochemical drive (N) Feb. 24 *72
Beryllium:
 Next wonder metal? Feb. 10 158
 U. K. uses no pressure in powder route to beryllium (N) Oct. 20 74
 Beryllium oxide Oct. 20 84
 Beta-propiolactone — Broad use potential Apr. 7 74

Book Reviews: Advances in pest control research Vol. 1 ed. R. L. Metcalf Aug. 11

Applied statistics for engineers Aug. 11
 William Volk Aug. 11

Catalysis Vol. 5 ed. P. H. Emmett Jan. 13

Chemical engineering in the coal industry. Forbes W. Sharpley Jan. 27

Chemical reaction engineering ed. Dr. K. Rietema June 2

Chemistry of heterocyclic compounds Vol. 11—Phenazines. Swan & Felton Mar. 10

Complexometric titrations. Arnold Schwarzenbach Mar. 10

Comprehensive inorganic chemistry Vol. 7 The elements and compounds of group IV-A. Kiug & Brasted Nov. 17

Elements of heat transfer. Jacob & Hawkins Feb. 24

Encyclopedia of chemical technology. First supplement. Kirk & Othmer Mar. 10

Engineering data book 7th Ed. Jan. 18

Engineering materials handbook ed. C. L. Mantell July 28 158

Free radicals in solution. Chevrel & Walling Jan. 27 162

Fundamentals of high polymers. O. A. Battista Dec. 29 104

The future supply of oil and gas. B. C. Netcheter May 6

Gas dynamics. Cambel & Jennings Sept. 8

Gmelin's handbook of inorganic chemistry. Gmelin Vol. 1 June 16

Heat transfer, Vol. 2. Max Jacob Feb. 24

Higher oxo alcohol. L. F. Hatch Mar. 24

Industrial chemicals, ed. W. L. Faith & others Feb. 10

Industrial hygiene and toxicology. Vol. 1, 2nd ed. F. A. Fatty Nov. 8 172

Introduction to nuclear engineering. Richard Stephenson Oct. 20

Ion exchange resins. Robert Kunin Aug. 11

Ion exchangers in organic and biochemistry ed. Calmon & Kressman Jan. 13

Management for engineers. H. C. Heimer July 14 174

Money and the chemical engineer. Osburn & Kammermeyer June 30

Oral communication of technical information. H. S. Casey Aug. 11

Organic electrode processes. M. J. Allen Sept. 22

Petroleum refinery engineering. W. L. Nelson Oct. 20

Plant design and economics for chemical engineers. M. S. Peters. May 19

Plant engineering practice, editors of "Plant Engineering" June 2

Plastic application series ed. H. R. Simons. Polyethylene. T. O. J. Kresser; Polyurethanes. B. A. Dombrowski; Plastic sheet forming. R. Z. Butzko; Polyamides. D. E. Floyd; Fluorocarbons. M. A. Rudner; Celluloses. W. D. Paist Aug. 25

Polyethylene—the technology and uses of ethylene polymerized. Renfrew & Morgan Feb. 15

Process dynamics: dynamic behavior of the production process. D. P. Campbell Dec. 15

Process engineering in the food industry. R. J. Clarke Apr. 21

The properties of gases and liquids. Reid & Sherwood Oct. 6

Radioisotopes—a new tool for industry. Sidney Jefferson May 19

Recent advances in the engineering sciences Dec. 1 156
 Southwest resources handbook. Jan. 27 162
 Soviet education for science and technology Jan. 27 163
 Textile chemicals and auxiliaries with special reference to surfactants ed. Speer & Schwartz Apr. 7 179
 Thermodynamics for chemical engineers. Weber & Meissner Apr. 21 182
 Tracer applications for the study of organic reactions Sept. 22 216
 Volumetric analysis, Vol. 3. Kolthoff & Belcher with Stenger & Matsuyama Feb. 10 170
 Boron—Boron fuel process brought into focus (N) June 20 56
 Boron fuels held for volume output (N) Dec. 15 *76
 Bromine—Michigan Chemical's new bromine plant taps rich oil-field brine (N) June 2 *51
Butylene:
 Butylene? Watch rubber. J. W. Bradley & others (tables). Feb. 24 92
 N-butylene isomers June 30 66
 Texas Butadiene & Chemical's plant wins butylene isomers (N) July 14 *84

C

Calcium carbonate—Carbium July 14 90
Calculations:
 Assure full range flow control. Joseph Conison (charts) Dec. 1 *207
 Calculate adequate rupture disk size. J. G. Lowenstein Jan. 13 157
 Calculate fractional powers by chart. Bernard Liss (D.N.) June 30 118
 Calculate height of a fluidized bed. Francis & Carbone (P.N.) Mar. 10 158
 Chart converts flow units. J. A. Seiner (D.N.) Oct. 20 170
 Charts give you percent conversion in each reactor stage. T. M. Jenney Mar. 19 166
 Checkup on cooling tower operation. Bass & Green (charts) Dec. 1 *111
 Chemical proportioning calculations. J. R. Heier Jan. 27 129
 Computer speeds economic evaluations. J. F. Adams & others June 30 99
 Easy way to optimum exchangers. John Happel Sept. 8 135
 Equations give time-value of E. G. C. Lamont (D.N.) July 28 126
 Estimate engineering properties. W. R. Gambill (charts) Latent heat II Temperature v. heat of vaporization Jan. 13 159
 III Predict mixture heat of vaporization Feb. 10 137
 IV Find heat of fusion and sublimation Mar. 10 147
 Surface tension for pure liquids April 7 146
 Surface and interfacial tensions May 14 142
 Predict diffusion coefficient. D. June 2 125
 Predict liquid diffusivities. June 30 112
 Best methods for Prandtl number Aug. 25 121
 Estimate low-pressure gas viscosity Sept. 22 169
 How T and P change gas viscosity Oct. 20 157
 To get viscosity for a gas mixture Nov. 17 157
 Find distillation stages graphically. Horvath & Schubert (charts) Feb. 19 129
 For mass transfer—quick method finds optimum trays and reflux ratio. John Happel July 14 144
 Get relative volatility for binary solutions. R. F. Sweeny (D.N.) May 5 148
 Graph for Van Laar constants Lu & Lavergne (D.N.) Aug. 25 132
 Graphs—how to make and use more effective graphs. G. A. Lessells (charts) Sept. 22 *155
 How to scale up pilot plant data and equipment—report. E. C. Clark (charts) Oct. 6 *129
 Let computers pick your exchangers. R. E. Githens Jr. Mar. 10 *148
 Mass transfer operations. J. O. Osburn. see under "Chemical Engineering Refresher"
 Old trick averts error in figuring dilution. W. H. Fischer (P.N.) Sept. 8 149
 One slide-rule setting finds solids dilution. Merton Allen (P.N.) Apr. 21 168

Percent-time predicts process end. Herbert Borsoval (chart) (P.N.) Jan. 13 168
 Plant operations are easier to visualize when you use a yield and capacity chart. J. B. Charlton (charts) Mar. 24 142
 Read time direct in decimal units. H. J. Ramey Jr. (D.N.) Aug. 25 *181
 Reliability of a simple approximation. D. S. Davis (chart) (P.N.) Feb. 10 159
 Remember all three in cost analyses. F. C. Jelen (chart) Jan. 27 *123
 Rule-of-thumb finds water pipe size. William Resnick (P.N.) July 14 154
 Simple statistics beats blind problem. E. S. Louring (P.N.) Apr. 21 *166
 Speedy trial and error solution for pipe diameter. Taschner & Droter. See 8 138
 Thermal data for chlorine and HCl. C. J. Dobratz (charts & tables) Feb. 10 144
 Unusual graph papers and their uses. G. A. Lessells Aug. 11 141
 Use graph to design for optimum economic extraction. R. S. Olson. Oct. 6 142
 Use specific gravity like molarity. C. L. Murray (P.N.) Oct. 6 155
 Workshop gives optimum conditions. C. H. Li (charts & table) Apr. 7 151

Carbon:

Activated carbon Sept. 8 76
 Activated carbon in molded shapes Jan. 27 *78
 Costs of solvent recovery systems—for activated carbon systems, estimates of plant and operating costs. Barnaby & Davis (charts) Dec. 29 *51
 Fluid bed under trial regenerating carbon (N) Dec. 1 *62
 Industrial Sugars, Inc. new decolorizing process hangs on granular carbon (N) Mar. 10 *80
 Mountaineer Carbon Co. plant gives coal producer entrée to integrated process complex (N) June 30 *54
 Casting—American Smelting & Refining's continuous casting in quick-chill mold (N) May 5 *62
Catalysts:
 American Cyanamid's new aniline plant uses catalytic hydrogenation (N) May 19 *66
 C86 removes acetylene from olefin streams by selective hydrogenation Nov. 17 86
 Catalyst key to new chlorination process (N) May 19 68
 Cracking catalyst July 28 74
 Directed catalyst improves organics—top technical trend of the year Jan. 13 143
 Methyl borate Dec. 29 36
 Molecular sieves tame volatile liquid catalysts into a convenient particle easy to market April 7 *72
 Nickel-on-kieselguhr catalyst for olefin-to-hydrogenate fats and oils. Dec. 1 76
 Platinum catalyst keys new UOP isobutane process (N) April 31 66
 Polyether catalyst used for producing odorless urethane foam developed Nov. 17 84
 Tidewater Oil's giant Orthoflow fluid catalytic cracking unit—Cat cracker cuts allenes—dienes Oct. 12 *120
 "Transene" catalyst streamlines allene polymerization (N) Nov. 3 64
 Caustic soda—Kaiser Aluminum & Chemical caustic plant will supply nearby aluminum works (N) April 21 *70
Cement:
 Acid resisting cements cure sealing problems. P. C. Ziemke (P.N.) Jan. 13 163
 Inventory of new processes and technology May 5 125
 Nonflammable strong bonding cement Oct. 6 *68
 Two U. S. cement mills now save fuel and cut dust losses with new ACL calcining systems (N) April 21 *60
 Preheating cement kiln feed saves Btu's—Coplay Cement Mfg. Co. flowsheet Sept. 22 *146
Ceramics:
 Ceramic-coated wire June 16 74
 Cermet for 2,200 F. and above. Sept. 22 188
 Ductile ceramics: promising find (N) April 21 68
 Inventory of new processes and technology May 5 125
 Nuclear fuels, ceramics get a plant and patents (N) Sept. 22 78
 Thermoelectric ceramics can convert heat into electricity (N) Dec. 15 82
 Thin-walled ceramics in lightweight honeycomb structures Dec. 1 *78
 Cesium and rubidium chemicals. Feb. 16 92
"Chemical Engineering Cost File"
 I—Begin new cost-chart-table series here. Harold Gushin June 16 187
 II—Cost of process vessels. Harold Gushin July 14 158

III—Cost of heat exchangers...today.	
Melvyn Sotter (charts & tables)	151
IV—Current costs of materials and motor reducers.	
Harold Gushue	141
V—Cost of U-tube heat exchangers.	
H. J. De Lamater	141
VI—Flanged head floating head exchangers, 150, <i>pat. H. J. De Lamater</i>	Oct. 6
Nov. 17	166
VII—Floating head exchangers: split ring and removable bundle.	
H. J. De Lamater	Dec. 1
VIII Fixed tube sheet exchangers and kettle reboilers.	
H. J. De Lamater	Dec. 1
IX Floating head and fixed tube sheet heat exchangers. H. J. De Lamater	Dec. 29
IX Floating head and fixed tube sheet heat exchangers. H. J. De Lamater	Dec. 29
"Chemical Engineering Refresher"	
How to set up the necessary mathematics. Ball & Johnson	
Fit differential equation to standard form	Jan. 27
Solve second-order linear equations	Feb. 24
Mass transfer operations. J. O. Osburn	Mar. 24
Mechanics of mass transfer...Apr. 21	161
How to use mass transfer coefficient	May 19
How to modify mass transfer equation	June 16
Find number of theoretical stages	July 14
Transfer unit simplifies calculations	Aug. 11
Mass transfer behavior in fixed beds	Sept. 8
Correlate mass transfer coefficients	Oct. 6
Chemical Engineering Reports	
Atomic-age metal extraction. L. W. Coffey (charts)	Jan. 27 *107-122
For your next purification problem: crystallization. Garrett & Rosenbaum (tables)	Aug. 11 *125-140
High-temperature nonmetals. R. E. Bixler (charts & table)	Apr. 1 *125-150
How to cope with a water pollution problem...July 14 *129-140	
How to scale up pilot plant data and equipment. E. La Clark (charts)	Oct. 6 *121-140
Inventory of new processes and technology (tables)	May 5 *126-138
Manufactured gas. Frances Arndt	Mar. 24 *121-128
Materials of construction 1960 biannual report	Dec. 11 *137-176
High-temperature metals. E. N. Skinner Jr. (charts & tables)	Dec. 15 137
Directory of manufacturers	Dec. 15 142
Inventory of literature	Dec. 15 171
Operation and Maintenance. June 16 *141-148	
I—Industry trends in O. & M.	
Technical service groups. R. D. Barnard	June 16 *144
Rise of contract maintenance.	
Raphael Koenig	June 16 *146
How business conserves capital. J. Ernest Nachod	June 16 *150
II—Select and design for O. & M.	
Operations define dryer design.	
P. V. McCormick	June 16 *154
Continuous and batch filters. Glen R. Reed	June 16 *160
Materials handling equipment.	
Menary & Howe	June 16 *164
Thickeners and clarifiers. Glen O. Wilson	June 16 *168
Impurity removal performance.	
H. W. Dutton & others	June 16 *172
Chemical process pumps. R. R. Rhodes	June 16 *178
Plan '58—Modernize now for growth and profits (tables).	Nov. 3 *113-144
How modern is American industry?	Nov. 3 *113
Modernization, why and when.	Nov. 3 *117
Team effort diagnoses obsolescence.	
McClaine & Schrier	Nov. 3 *128
New equipment spurs process progress	
Five cases for modernization. Nov. 3 *139	
Review patent fundamentals. R. G. Crooks	Feb. 24 *121-136
Rockets and missiles. R. L. Noland (tables)	May 19 *145-160
10 top technical trends of the year	Jan. 13 *138-144
Use nonmetallic inorganics. Martin D. Robbins (tables)	Sept. 8 *129-134
Chemical Engineers	
Chilton, T. H.	June 16 212
Coates, Jesse	May 5 140
Dorr, J. V. N.	June 16 212
Gilbert, Frederick A.	Feb. 24 *179
Hirschkind, Wilhelm	April 1 *182
Hogen, O. A.	June 16 212
Kirkpatrick, S. D.	June 16 212
Lewis, W. K.	June 16 212
Modigliani, Dr. Piero	April 31 *196
Parkhurst, George L.	April 7 *188
Chemical Industry	
Air-fuel—cue for processing by industry? J. A. King	Oct. 6 *62
Celasees to use computer to probe chemical-formalin future	Oct. 6 66
Chemical growth slowing down?	(charts & tables)
Chemical overcapacity: causes and cures	Nov. 17 80
CPI spending plans—Will sagging chemical outlays perk up soon?	W. H. Char tener (charts & tables)
Europe's Common Market—chemical competition	Dec. 15 88
1967—chemical firms score in sales, find profit pickings slimmer.	W. H. Char tener (tables)
Russian chemicals: strength, weakness	Aug. 25 86
Special report on CPI modernization in '58 (tables)	Nov. 3 *113-144
How modern is American industry?	Nov. 3 *113
Modernization, why and when.	Nov. 3 *117
Team effort diagnoses obsolescence.	
McClaine & Schrier	Nov. 3 *128
New equipment spurs process progress	
Five cases for modernization.	Nov. 3 *139
Chemical milling of tough metals (N)	Apr. 7 62
Chlorinated p-xylenes now in pilot plant quantities	Mar. 16 92
Chlorination	
Catalyst key to new process (N)	May 19 66
Quick HCl chill highlights new perchloric process—flowsheet	May 5 *116
Chlorine	
Nerve gas—Chemical Corps., U. S. Army facilities at Muscle Shoals (N)	Sept. 22 *74
Radioisotopes measure mercury inventory at Australian chlorine plant (N)	Sept. 3 *64
Thermal data for chlorine and HCl. C. J. Dobratis (charts & tables)	Feb. 10 144
Chromium	
Crabbed alloy breakthrough?	Oct. 6 *160
Most efficient chromium route: case for chemical sleuth (N)	Sept. 22 78
Clarifiers—Operation and maintenance.	
Thickeners and clarifiers. G. O. Wilson	June 16 *168
Coral	
Automatic coal-fired packaged generator yields ready steam	June 2 *66
Carbon plant of Mountaineer Carbon Co. gives coal producer entree to integrated process complex (N)	June 30 *54
Methanation ideas—Researchers at Columbian Univ. applying atomic radiation; Australians use fluidized-bed hydrogenation process (N)	Mar. 24 64
Pittsburgh Consolidation Coal slurry setup readies coal for pipeline (N)	Oct. 6 *54
Coatings	
Ceramic-coated wire	June 16 7
Epoxy coatings—gun solves shop problems	Nov. 17 *86
Equipment can now do polyethylene coat (table)	Sept. 8 152
High-temperature coatings for graphite	Sept. 22 *188
Koropons coatings excel in corrosion resistance, adhesion	Mar. 19 90
Lining technique. Castellay lining by welding, halves vessel cost.	J. F. De Lorenzo
Map your protective coating program	Dec. 23 *70
Oil's prevention program	Feb. 10 *125
Modified epoxy coating. Permaclad Towercoats licks cooling tower problem	Dec. 29 72
Neoprene-nylon bubble shields tank cars	July 28 *74
New copolymer of butadiene and styrene for coating metals	Sept. 3 76
New coating processes deposit molybdenum	July 14 164
New process sprays any metal	Oct. 6 164
Nicrostainless alloy technique turns mild steel into stainles	Nov. 17 178
Nikopon chemical process plates resistant nickel	Jan. 18 *172
Novel mobile coating for chemical equipment	Jan. 27 *152
Permaspray—protective coating	June 2 62
Polyethylene coating for paper, cellophane and foil	July 14 90
Protective coatings limit corrosion	
Corrosion refresher on cause and cure.	
R. J. Jelinek (table)	Mar. 10 163
Rusinova polyols for caustic-resistant coatings	Feb. 24 78
Special coatings will resist spillage.	
R. Cushing (table)	Feb. 24 166
Spray on hard tungsten carbide	June 30 *126
Wood won't rot if coated with plastic (N)	Mar. 10 82
Cobalt	
Calera Mining converts to electrolytic cobalt route (N)	Jan. 27 *60
Co-60 opens new route to low-cost detergent (N)	Nov. 3 61
Pressure leach purges arsenic from ore cobalt via Sili process (N)	Jan. 13 66
Coke and Coke Products	
Carbon plant of Mountaineer Carbon Co. gives coal producer entree to integrated process complex (N)	June 20 *54
Refinery calcining gives Al-grade petroleum coke (N)	Feb. 24 64
Scrubber ends coker's naphthalene woes (N)	May 19 *68
Columbium—Columbium and tantalum—nowsheet. Electro Metallurgical Co. extraction	Nov. 3 *184
Computers	
Celasees to use computer to probe methanol-formalin future	Oct. 6 66
Computer speeds economic evaluations.	
J. F. Adams & others	June 30 99
Humble Oil & Refining—model refinery operates inside giant computer (N)	Feb. 24 72
Information retrieval finds it in minutes. M. W. Kellogg Information Retrieval Center (N)	Dec. 29 *78
Let computers pick your exchanges.	
R. B. Gilhous Jr.	Mar. 16 *142
New computer shorthand cuts programming time (N)	Oct. 20 70
Program-to-desk flow of data hastened by IBM (N)	July 14 84
Phillips Petroleum's new ethylene plant adopts data-handling unit (N)	Aug. 11 *84
Process dynamics get computer scrutiny at Monsanto (N)	Feb. 24 *64
Soceny Mobil's speedy communications extend computer's reach (N)	Sept. 3 62
Stimulus to creative engineering: problem solving with computers. Buell & Pollock	Oct. 20 *147
Concentration—Hercules Powder process chops cost of concentrating nitric acid (N)	July 28 66
Condensation—Avoid excess dilution in recovering condensates. J. A. Seiner (P. N.)	Dec. 29 *66
Construction	
Design for lower construction costs. R. J. Rourds	Mar. 24 *123
How to get more accurate plant cost estimates. N. G. Bach (charts & tables)	Sept. 22 *155
Plant building takes a breather. W. H. Char tener (charts & table)	Jan. 13 106
Plastic panel coverings: handle tough plant conditions. P. N. Cheremisinoff (tables)	May 5 *153
Union Tank Car Co. dome speeds up materials handling (N)	Nov. 3 *53
Contacting	
Boeing Airplane's Wichita, Kan. plant—two-stage contacting oxidizes cyanide (N)	Mar. 24 *63
Rotary kiln enters iron-ore reduction race (N)	May 5 *52
Shell Oil's better desulphurizing kerosene-oil setup (N)	Nov. 3 *54
Tidewater Oil's giant Orthoflow fluid catalytic cracking unit—Cat cracker sets challenges—flowsheet	Oct. 6 *120
Continuous Processing	
American Smelting & Refining's continuous casting in quick-chill mold (N)	May 5 *62
Brown Co.'s magnesia-base pulping breaks pollution stalemate (N)	Sept. 8 *60
Continuous analyzer eases alloy determination (N)	Aug. 21 88
Continuous digester gets better pulp faster (N)	June 2 *55
Continuous rubber route does a new look—flowsheet	June 2 *102
Continuous vulcanizer cures extrusion fast (N)	May 5 *60
Fluid oxidation slashes metallic oxide costs (N)	Dec. 15 *78
Fluid-bed under trial regenerating carbon (N)	Dec. 1 *62
Goodyear Tire & Rubber's expanded plant uses continuous route (N)	Jan. 27 60
Hydrazine via NH ₃ today—flowsheet	July 14 *120
New stream analyzers develop at Oak Ridge (N)	Oct. 20 76
New waste disposal process—wet oxidation. F. J. Zimmerman (charts & table)	Aug. 25 *117
Operation and maintenance—continuous and batch filters. G. G. Reed	June 16 *160
Tower reactor speeds multiphase reactions (N)	July 14 86
"Transient" catalyst streamlines silicone polymerization (N)	Nov. 3 64
Controls	
Air valves actuated by electric signal (N)	Jan. 27 72
Airplane overheat-detector goes industrial	Aug. 21 *78

- Full process control wins pilot-scale role—California Research Corp. (N)** July 14 *78
- Microwave controls supply of plant waste at Olin Matheson Chemical's East Alton, Ill. plant (N)** Apr. 7 *63
- New stream analyzers developed at Oak Ridge (N)** Oct. 20 76
- Robot operator for fire door.** P. C. Ziemke (P.N.) Aug. 11 *153
- Water-still controls itself automatically.** H. Leslie Bullock (P. N.) Dec. 29 *65
- Conversion chart—Plant operations are easier to visualize when you use a yield and capacity chart.** J. B. Charlton (charts) Mar. 24 142
- Conveyors**
- Pneumatic conveying setup handles polyethylene at Phillips Chemical Co. (N) Sept. 8 *66
 - Pneumatic conveyor cools hydrocrystallized. R. W. Moore (P.N.) Nov. 3 *46
 - Practical pneumatic conveyor design. John Fischer June 3 *114
- Cooling Towers**
- Checkup on cooling tower operation. B. A. Green (charts) Dec. 1 *111
 - Esso's Baton Rouge slanted cooling tower designed to thwart icing (N) Nov. 17 *78
 - Modified epoxy coating. Permaclad Towercoat. Licks problem... Dec. 29 72
 - Use salt water cooling towers. W. W. Mitchell June 16 *181
- Copper**
- American Smelting & Refining's copper flows continuously from new arc furnace (N) Mar. 10 *78
 - Ten new copper alloys downstream corrosion... June 16 *194
- Corrosion**
- Aluminum-covered storage building Sept. 8 *154
 - Automatic lead cladding slashes costs June 30 *122
 - Build or repair with epoxy-glass laminate. Nook & Cotters Jan. 27 *148
 - Chromium-based alloy breakthrough! Oct. 6 *180
 - Cooling tower problem licked with modified epoxy coating. Permaclad Towercoat... Dec. 29 72
 - Corrosion—refresher on cause and cure. R. V. Jelinek (charts & tables) Introduction to the series. July 28 114
 - How oxidative corrosion occurs Aug. 25 *126
 - How environment directs corrosion control... Sept. 22 163
 - Protective coatings limit corrosion Oct. 20 168
 - Design factors in corrosion control Nov. 17 *151
 - Consider nonoxidative corrosion where equipment carries molten metal... Dec. 29 *56
 - Corrosion-resistant putty puts new life into sea water pumps... Aug. 11 *162
 - Cutting corrosion in refrigerant drying. J. A. Seiner (P.N.) Dec. 1 *126
 - Ductile vanadium—a new material for construction?... Dec. 15 *196
 - Easy-to-work titanium alloys. Aug. 11 162
 - Fluorocarbon plastic takes on new jobs Aug. 11 *158
 - Foamed silica: hard-to-break properties (table) Aug. 25 142
 - A fresh approach to corrosion problems July 14 164
 - Glass drainlines catch on... June 16 *196
 - Hard carbide inserts lick valve erosion Feb. 10 *156
 - How much life in graphite heat exchangers? C. P. Dillon Sept. 27 *184
 - Infrared lamps stop steel corrosion Aug. 25 146
 - Inset defector reduces weak acid corrosion. J. A. Seiner (P.N.) Oct. 6 *154
 - Lining technique, Hastelloy lining by welding, halves vessel cost. J. F. De Lorenzo Dec. 29 *70
 - Low-cost cryogenic steel goes commercial. J. Procter (charts) July 14 160
 - Lubricate under corrosive conditions (chart) Feb. 10 154
 - Map your protective coating program—Dow's prevention program. Feb. 19 *125
 - Meters: quick way to optimum inhibitor... Dec. 29 *74
 - New coatings boost graphite applications Sept. 22 *158
 - New optical methods spot hidden corrosion. J. M. Holman... Apr. 21 *170
 - New wrought iron shows superior resistance (N) Mar. 34 *156
 - Niphos chemical process plates resistant nickel... Jan. 13 *172
 - Nonmetallic inorganics for severe processing conditions. M. D. Robbins (report) (tables) Sept. 8 *128
 - Nylon 6 for process applications. D. L. Duncan Dec. 1 *180
 - Plastic for tanks. W. Reynold. Mar. 24 *152
 - Plastic metals minimize plant shutdowns... Nov. 3 *150
- Plastic panel coverings: handle tough plant conditions.** P. N. Chernomisoff (tables) May 5 *152
- Plastic tower design.** P. L. McWhorter Apr. 7 *164
- Plywood ducts resist corrosives.** Feb. 10 158
- Polyethylene for coating equipment (table)** Sept. 8 *152
- Resistant gaskets end sealing problems.** B. G. Staples... Oct. 20 *180
- Rough material cuts pump consumption.** J. R. Drabek Mar. 19 *163
- Shock-resistant glass.** July 28 144
- Spray on hard tungsten carbide** June 30 *126
- Stainless D316 better than type 316 (table)** Dec. 15 194
- Steel—new alloy steels beat process bugaboos.** Roach & Hall (tables) I May 19-20, II June 2 184
- Tantalum-lined equipment.** Dec. 29 74
- Titanium-alloys stronger, more resistant.** June 3 152
- Twin new copper alloys down stress corrosion** June 16 *194
- Underground corrosion—NBS investigations** Sept. 3 154
- What's your rust index?** Oct. 6 162
- What you can do to reduce stress corrosion.** F. J. Poss... July 28 140
- Wood—is it on the way out?** July 14 164
- Zirconium is more popular than ever for nuclear reactors.** Nov. 17 174
- Zirconium outlasts stainless in chlorine service** June 16 *198
- Costs**
- CE Cost File see under "Chemical Engineering Cost File"
 - Commercial Solvents' methylamines plant at Terre Haute, Ind. engineering shortcuts slice plant costs (N) Mar. 24 *151
 - Consider buying used equipment. R. H. Insande... July 14 *141
 - Costs favor hot carbonate process for bulk removal of acid gases. A. G. Eickmeyer (charts & tables) Aug. 25 113
 - Design for lower construction costs. R. C. Rohrdsen... Mar. 24 *133
 - Equipment costs—Marshall and Stevens annual indexes of comparative equipment costs 1918 to 1957 (charts & tables) Sept. 22 143
 - Estimate cost of graphite equipment. John Reys (charts)... Feb. 24 *137
 - How to allocate process steam costs. Katell & Joyce (charts) Mar. 19 152
 - How to get more accurate plant cost estimates. N. G. Bach (charts & tables) Sept. 22 *155
 - Joint products and byproducts—how to deal with costs. Dershaw & McEntee... Dec. 29 61
 - Let computers pick your exchangers. R. E. Githens Jr. Mar. 10 *143
 - Major cost analysis methods: solid equivalent answers. P. C. Johnson July 28 116
 - Marshall and Stevens indexes of comparative equipment costs see under Marshall and Stevens etc.
 - Molecular sieves—sharp, selective adsorption pays off (N) Oct. 20 *66
 - Nuclear fuel costs? Nobody's sure Dec. 1 72
 - Optimize your maintenance stores. R. E. Bley (chart) Oct. 20 174
 - Pilot plants in process technology. E. L. Clark... Apr. 21 *155
 - Preheating cement kiln feed saves Btu's—Copart Cement Mfg. Co. flowsheet Sept. 22 *146
 - Rate economic factors by importance. Kenneth Finlayson... Jan. 13 151
 - Reduce your maintenance costs. G. C. Derrick July 28 132
 - Remember all three in cost analyses. F. C. Jelen (chart) Jan. 27 *128
 - Selecting ejectors for high vacuum. C. G. Linck (charts) Jan. 18 *145
 - Solvent recovery systems costs. Borchardt Davis (charts) Dec. 29 *51
 - South Dakota School of Mines & Technology students save 75% by designing and installing equipment in new laboratories... Oct. 20 *172
 - Cresylic acid—Pitt-Consol Chemical's new refining process at Newark, N. J. plant may zoom aryl mercaptan output... Mar. 16 *83
- Crystallization**
- For your next purification problem: crystallization—report. Garrett & Rosenbaum (tables) Aug. 11 *125
 - Snapshots guide growth of better crystals (N) Sept. 22 158
 - Sodium sulfate process key step-crystallization—flowsheet Aug. 11 *116
 - Curing agents—Anhydride curing lengthens epoxy pot-life... Dec. 1 *78
- D**
- Decolorizing—new Industrial Sugars' process hangs on granular carbon (N)** Mar. 10 *80
- Design**
- Air-cooled heat exchangers. E. C. Smith (charts & tables) Nov. 17 *145
 - Assure full range flow control. Joseph Conison (charts) Dec. 1 *107
 - Chart visualizes heat transfer relations. E. J. Gibbons (D.N.) June 2 129
 - Charts give percent conversion in each reactor stage. T. M. Jenney... May 19 166
 - Construction and design studies for nuclear reactors (N) Dec. 29 27
 - Continuous rubber route done a new Odessa Tex plant. Robbins (N) June 2 *102
 - Conversion chart—plant operations are easier to visualize when you use a yield and capacity chart. J. B. Charlton (charts) Mar. 24 142
 - Corrosion control design factors. R. V. Jelinek... Nov. 17 *151
 - Crystallization—for your next purification problem—report. Garrett & Rosenbaum (tables) Aug. 11 *125
 - Design for power construction costs. R. C. Rohrdsen... Mar. 24 *133
 - Easy way to optimum exchangers. John Happel Sept. 8 135
 - First U. S. Invents methanol plant (N) Feb. 24 *62
 - Flare stacks—How tall? F. T. Bodurtha Jr. (charts) Dec. 15 *177
 - For mass transfer—quick method finds optimum trays and reflux ratio. John Happel... July 14 144
 - Heat exchanger design calculations. Ning Hsing Chen see under Heat Exchangers
 - Horizontal fractionator looms as potential rival to multiplate high-vacuum tower (N) Feb. 10 *76
 - How to design for radiant heating. L. M. Polentz (charts & tables) I Apr. 7-197, II Apr. 21 151
 - How to scale up pilot plant data and equipment—report. E. L. Clark (charts) Oct. 6 *129
 - Huge fabrication job for sodium-cooled reactor poses design problems (N) June 2 *56
 - Keys to pilot plant success: equipment and safety. E. L. Clark... July 29 119
 - Let computers pick your exchangers. R. E. Githens Jr. Mar. 10 *143
 - Mass transfer operations. J. O. Osburn Mar. 24 145
 - Mechanics of mass transfer. April 21 *161
 - How to use mass transfer coefficients... May 19 169
 - How to modify mass transfer equations... June 16 *183
 - Find number of theoretical stages. July 14 147
 - Transfer unit simplifies calculations Aug. 11 147
 - Mass transfer behavior in fixed beds Sept. 8 142
 - Correlate mass transfer coefficients Oct. 6 *146
 - Estimate efficiency in mass transfer Dec. 1 *119
 - Nomograph finds condenser film temperature. Rodriguez & Smith. Mar. 19 150
 - Operation and maintenance—report June 16 *41-181
 - II—Select and design for O. M. Operations define diver design. P. Y. McCormick... June 16 *154
 - Continuous and batch filters. Glen R. Reed... June 16 *160
 - Materials handling equipment. Menary & Howe... June 16 *164
 - Thickeners and clarifiers. Glenn O. Wilson... June 16 *168
 - Improve agitator performance. H. W. Dutton Jr. & others June 16 *172
 - Chemical process pumps. R. R. Rhodes... June 16 *178
 - Pilot plants in Process technology. E. L. Clark... Apr. 21 *155
 - Plastic model cat reformer aids reactor design (N) Feb. 10 *78
 - Practical pneumatic conveyor design. John Fischer... June 2 *114
 - Procedures on rupture disk installations. J. E. Bigham... Apr. 7 *143
 - Processors step up instrument developments (N) July 14 *80
 - Salt water cooling towers. W. V. Mitchell... June 16 *181
 - Scrubber ends coker's naphthalene woes (N) May 19 *68
 - Selecting ejectors for high vacuum. C. G. Linck (charts) Jan. 18 *146
 - Solve batch liquid metering problems with a volumetric tank. Max Bass Oct. 20 *150
 - Unit operations in the pilot plant. E. L. Clark... June 2 *119
 - Vertical pumps. Cannon & Douglass Mar. 10 *139
 - Water models used to design turbines (N) Dec. 29 *27
 - Water simulates gas flow in model tests (N) Oct. 20 70
 - Weather eye guides plant layout and design at Dow Chemical (N) Apr. 7 *64

Worksheet gives optimum conditions C. H. Li (charts & tables). Apr. 7	151
Design Notebook	
Calculate fractional powers by chart Bernard Liss June 30	118
Centrifugation can select solids by density Merton Allen Dec. 15	*182
Chart converts flow units J. A. Seiner Oct. 20	170
Chart visualizes heat transfer relations E. J. Gibbons June 2	129
Collecting integrated gaseous samples Brief—Drinker Nov. 1	162
Easy way to fabricate shows C. A. Lee July 28	*125
Eductor cuts noise of live steam heating J. F. Kuong Aug. 25	*131
Equations give time-value of \$ G. C. Lammers July 28	128
Get relative volatility for binary solutions R. F. Sweeny May 5	148
Glass sink trap becomes reflux separator R. A. Snedeker May 5	150
Graph for Van Laar constant Lu & Lavergne Aug. 25	132
Here's your wallet-size slide rule E. C. Pirie Sept. 22	*175
Home washer doubles as pilot extractor Seltzer & Paxton Apr. 7	*158
How many tubes in an exchanger shell? R. L. Senn (chart) Dec. 15	183
Inside insulation saves cost R. F. Benenati May 5	*148
"Internal seal pots" eliminate gage plugging L. E. McLane June 14	*117
Instant bottling machine—constant-head feeder H. Leslie Bullock Oct. 20	170
Kill static in lab screening Merton Allen Sept. 22	*176
Material balance shows homogeneous flow G. A. Lessells Apr. 7	*160
Measure gas temperatures with a flow meter D. S. Scott (chart) Nov. 17	181
New data supplement liquid viscosity chart J. A. Seiner Sept. 22	178
Nomograph gives steam condensed by air Y. P. Vynshi June 2	130
Plastic protection for vessel insulation P. N. Cheremisinoff June 30	118
Quick calibration for small gas flow meters Kunte & Pai Apr. 7	*160
Read time direct in decimal units H. J. Ramey Jr. Aug. 25	*181
Simple way to measure steam quality Robert Lemlich Apr. 7	*162
This chart converts pressure units J. A. Seiner May 5	150
Vent breather protects solvent storage tanks G. W. Hamilton Oct. 20	*169
Versatile reflux system for distillations W. T. Klappert June 2	130
Detergents—Co-60 opens new route to low-cost detergents (N.) Nov. 3	86
Dioxydites June 16	74
Diffusion—Estimate engineering properties W. R. Gambill see under Engineering	
Distillation	
Find distillation stages graphically Horvath & Schubert (charts) Feb. 10	129
Forced transfer—quick method finds optimum trays and reflux ratio John Happel July 14	144
Hydrazine via NH ₃ today—flowsheet May 14	*120
Inco nickel process pioneers sulfur distillation (N.) Apr. 7	*61
Mass transfer operations J. O. Osburn Mar. 24	146
Mechanics of mass transfer Apr. 21	*161
How to use mass transfer coefficients John May 19	160
How to modify mass transfer equations J. O. Osburn June 16	183
Find number of theoretical stages July 14	147
Transfer unit simplifies calculations Aug. 11	147
Mass transfer behavior in fixed beds Sept. 8	143
Correlate mass transfer coefficients Oct. 6	146
Estimate efficiency in mass transfer Dec. 1	119
Versatile reflux system for distillations W. T. Klappert (D.N.) June 2	*180
Water-still controls itself automatically, H. Leslie Bullock (P.N.) Dec. 29	*85
Drafting—Let photography speed your drafting Hammond & Kinster May 19	*161
Drawing—Handy way to scale drawings for flow sheets R. H. Berg (P.N.) May 19	174
Drilling rubber-lined pipe under vacuum Foster Franks (P.N.) Feb. 24	*152
Drugs—Oral diuretic—Esdrex TM Dec. 15	90
Dryers—Operation and maintenance—Operations define dryer design F. Y. McCormick June 16	*154
Dust and Fume Handling: Considerations for controlling dust and fumes O'Mara & Flodin May 5	*193
Flare stacks—How tall? F. T. Bodurtha Jr. Dec. 15	*177
Poisoned metals studied as smog deter rents (N.) Aug. 11	82
Multijet flare tames smoky flames (N) June 20	50
Ohio Standard's giant waste CO boiler saves heat, cuts fumes (N.) May 5	58
Troubleshooting dust collectors W. E. Archer Dec. 15	*188
Two U. S. cement mills now save fuel avoid dust losses with new ACL calcining systems (N.) Apr. 21	*60
U. S. Steel giant fume catcher stops fluoride emission (N.) Feb. 24	*66
Dyes—Ramazol dyes Nov. 3	72
E	
Economics	
American economy in 1958: twice as big! (table) Apr. 21	86
Atom-fuel—use for processing by in dustry J. A. King Oct. 6	*62
Chemical growth slowing down (charts & tables) Sept. 8	72
Chemical overcapacity: causes and cures Nov. 17	20
CPI spending plans—Will sagging chemical outlays perk up soon? W. H. Chartener (charts & tables) Dec. 15	84
Chemical spending: firms retrench and wait W. H. Chartener (table) Mar. 19	86
Computer speeds economic evaluations J. F. Adams & others June 29	99
Consider buying used equipment R. R. Imsande July 14	*141
Depreciation: there'll be some changes made (charts) July 28	70
Ethylene: technology paints the market picture J. W. Bradley & others (tables) Jan. 27	*88
Europe's Common Market: chemical competition (N.) Dec. 16	88
Industry output in 1958 Feb. 24	95
Inflation from bigger deficits N. A. necessary Aug. 25	70
It's a pin a dollar sign on industrial research Dec. 15	88
MAPI formula eases modernization decision Aug. 25	72
Metal supplies: more than enough at last C. H. Chilton (charts) June 30	*73
More aromatics from petroleum (tables) May 5	78
1957—chemical firms score in sales, find profit pickings slimmer W. H. Chartener (tables) April 7	86
Nuclear fuel costs? Nobody's sure Dec. 1	72
Nuclear industry—1958-1968 April 7	90
Pesticides figure on boost from Soil Bank Melvin Goldberg (chart & table) Feb. 24	*102
Petroleum feels the pinch (charts & tables) J. B. Bacon Mar. 24	88
PO ₄ is making news in fertilizers TVA's development program (charts & table) Dec. 29	*32
Plant building takes a breather W. H. Chartener (charts & table) Jan. 18	106
Plastics race: chemical industry will stay on top R. P. Windisch (table) July 14	98
Polyethylene—what's happening to lin ear polyethylene? (charts & table) Sept. 22	86
Refiners must change their yield pat terns—bigger share for middle distil lates and fuel oil (tables) Nov. 3	66
Research §§: the big spark W. H. Chartener (charts) Jan. 13	110
Rubber chemicals—trends France Arne (tables) Jan. 16	94
Russian chemicals: strength, weakness Aug. 25	70
Silicon market: shrinking as it grows (charts & tables) Mar. 10	102
Solvent blues: It's not just the reces sion Aug. 11	90
Special report on CPI modernization in '59 (tables) Nov. 3	*113-144
How modern is American industry? Nov. 3	*113
Modernization, why and when Nov. 3	*117
Team effort diagnoses obsolescence McClaine & Schriener Nov. 3	*123
New equipment spurs progress Nov. 3	*131
Five cases for modernization Nov. 3	*138
Spend octane dollars on today's know how (table) Oct. 26	78
Uranium industry needs a new incen tive C. S. Cronan (charts) June 2	72
Editorials—For 1958: 26 times ... and better Jan. 13	127
Education	
College-industry meeting sponsored by ASME (N.) Mar. 24	164
Engineers get a graduate school Mar. 10	174
Engineers go back to high school Joseph Cryden Nov. 17	*163
Scientists — Purdue Univ. studies Apr. 21	180
\$70,000 given to science writing (N) Mar. 24	164
What's wrong with engineering educa tion J. R. Killian, Jr., F. H. Rhodes Apr. 7	173
Electricity	
Columbia-Southern Chemical plant uses home-made rectifiers (N.) Dec. 1	*56
Direct thermo-electric power efficiency upped (N.) May 19	70
Fuel cell converts gases to electricity top technical trend of the year Jan. 13	142
Intense arc pierces temperature barrier (N.) Dec. 29	*94
Kill static in lab screening Merton Allen (D.N.) Sept. 22	*176
Thermoelectric ceramics can convert heat into electricity (N.) Dec. 15	83
Electrochemistry defines oxidative cor rosion—Corrosion Refresher R. J. Jelinek Aug. 26	*125
Electrodes—Giant electrodes manufac ture by National Carbon backs trend to huge arc furnaces—flowsheet Apr. 7	*128
Electrolysis	
High-purity manganese via electrolysis flowsheet May 19	*136
Production of hydrogen by high-pres sure electrolysis of water (N.) Oct. 6	54
Electrorefining process of Inco gets pure nickel from NiS—sulfide anode cancels sinter and smelt (N.) Apr. 7	*60
Electronics—Silicon market: shrinking as it grows (charts & tables) Mar. 16	102
Emulsifying agent—Aluminum silicate Nov. 3	*73
Engineering	
Atomic-age metal extraction—report L. W. Coffey (charts) Jan. 27	*107
Commercial Solvents methylaniline plant at Terre Haute Ind.—engineer ing shortcuts slice plant costs (N) Oct. 20	*73
Conversion chart—plant operations are easier to visualize when you use a yield and capacity chart J. B. Charl ton (charts) Mar. 24	142
Estimate engineering properties W. F. Gambill (charts) Jan. 18	142
Latent heat II Temperature vs. heat of vaporization Jan. 18	159
III Predict mixture heat of vaporiza tion Feb. 10	187
IV Find heat of fusion and sublima tion Mar. 10	147
Surface tension for pure liquids Apr. 7	146
Surface and interfacial tensions May 5	143
Predict diffusion coefficient D. June 2	125
Predict liquid diffusivities June 30	112
Best methods for Frandt number Aug. 25	121
Estimate low-pressure gas viscosity Sept. 22	169
How T and P change gas viscosity Oct. 20	157
To get viscosity for a gas mixture Nov. 17	187
Information retrieval finds it in min utes M. W. Kellogg Information Re trieval Center (N) Dec. 29	*28
Iron recovery demands engineering compromises—Inco flowsheet June 16	*122
Major cost analysis methods yield equivalent answers F. C. Yelen July 28	116
Mass transfer operations—CE Refresher James O. Osburn see under "Chem ical Engineering Refresher"	
Operation and maintenance—report June 16	*141
I Industry trends in O & M Techni cal service groups R. D. Barnard June 16	*144
Rise of contract maintenance Raph ael Katzen June 16	*146
How leasing conserves capital J. Ernest Nachod June 16	150
II Design design for O & M Oper ations define dryer design P. Y. McCormick June 16	*154
Continuous and batch filters Glen R. Read June 16	*160
Materials handling equipment Men ary & Howe June 16	164
Thickeners and clarifiers Glenn O. Wilson June 16	*168
Improve agitator performance H. W. Dutton & others June 16	*172
Chemical process pumps R. R. Rhodes June 16	*178
Pilot plants in process technology E. L. Clark April 21	*155
Putting a value on engineering work R. G. Trout (chart) Sept. 8	146
Rocket and missile report May. 9	*145-160
Rocket-propellant process—Astrodyne, Inc. solid-propellant plant—flowsheet April 7	*196
Spend octane dollars on today's know how (table) Oct. 20	78
Stimulant to creative engineering— problem solving by computer Buell & Pollock Oct. 20	*147
10 top technical trends of the year report Jan. 13	*138
3 materials vie for role as reactor cool ant—flowsheet June 20	*90

Index to Vol. 64, January to December 1958

Tidewater Oil's giant Orthoflow fluid catalytic cracking unit—Cat cracker sets challenges—downsheet... Oct. 6	*120	Flowmeter	June 16 *82
Unit operations in the pilot plant... E. L. Clark	July 2 *119	Flowmeter, gas	Aug. 11 *74
Weather eye guides plant layout and design at Dow Chemical (N)... Apr. 7	*84	Flowmeter, mass	Mar. 17 *123
Engineers at Dow Chemical (N)		Furnace, vacuum induction	Mar. 24 *82
Brainstorming: now it can work for you. J. G. Mason	July 14 165	Gage, density	Mar. 10 100
Chemical engineers continue to lose ground. Dr. R. Katzen (charts)	Mar. 24 161	Gage, level	Nov. 3 76
Chemical unions may merge in 1959 (N)	Oct. 20 80	Gage, vacuum	Sept. 22 209
Civil service in the atomic age... Civil service	July 165	Gaskets, reusable	July 14 *96
Conferences probe ways to upgrade engineer use (N)... Mar. 10 *78		Gate, slide	June 30 *74
Does your employer own your knowledge?—recent legal decisions. July 28 *127		Generator, inert-gas	Sept. 22 *267
Du Pont plans to pay more... Feb. 24 166		Generator, nitrogen	Oct. 20 *193
Engineers go back to high school Joseph Cryden	Nov. 17 *183	Generator, packaged	June 2 *66
EJC requests ban on technology Dec. 15 165		Grinding system, pre-engineered	
ESG—new union in gestation stage Jan. 18 184	Apr. 21 180	Heat exchanger—waste heat recovery	Dec. 15 *94
Final score: no one without job offer (table)	Oct. 20 171	Heater, finned-tube	July 22 *80
Get a job from the man who owns it: the interviewer. R. J. Obrechta Dec. 15 *184		Heaters, radiant	Dec. 1 148
Graduate school for engineers. Mar. 10 174		Heating element	May 5 *70
How chemical engineers serve Uncle Sam. R. R. Freeman	May 5 *161	Heating modules	Aug. 25 *80
How "Dear Boss" letters spawn creativity. Carl Pacifico	Jan. 13 *181	Hoist, super-lift	May 5 *74
How many engineers belong to unions? Mar. 11 156		Homogenizer, ultrasonic	Mar. 10 *94
How to measure individual performance. R. G. Trout	Sept. 22 173	Homogenizer-disperser	Aug. 11 100
How to run an effective meeting W. L. Knighten	Jan. 27 *157	Hopper prevents bin stoppage	Aug. 7 *75
Immigration of professional men. Apr. 21 188		Horn, warning	July 22 *154
It's true: the man can make the job! Apr. 21 179		Hose, flexible	Dec. 1 148
Kaiser Aluminum cuts engineering staff (N)	Mar. 24 164	Incubator, bacteria	Nov. 3 166
Lockheed Aircraft—encouraging swing in jobs	Aug. 11 180	Indicator, cake thickness for leaf filter	
A look at the future... Aug. 11 165		Indicator, moisture	Jan. 12 *95
National Engineers Week	Feb. 24 166	Indicator, motion	Nov. 17 193
Nationwide job pools place professionals Aug. 25 *183		Injector, additive	July 28 *39
North American needs research engineers (N)	Mar. 24 164	Inspector, fill-height	July 28 *30
Putting a valve on engineering work R. G. Trout (chart)	Sept. 8 146	Instrument, density	Dec. 1 *150
Salaries—a medley of salary data for 1958 (charts & tables)	Dec. 29 67	Insulation, metallic	Mar. 24 *80
Should you employers pay you over time? R. D. Stevens	Dec. 1 127	Insulation, pipe	Feb. 10 *100
Six sure steps to the top. O. A. Battista	Feb. 24 *165	Insulation, underground	Sept. 22 203
Starting salaries match all-time high Nov. 17 165		Insulation jackets	June 30 *74
Stimulant to creative engineering—problem solving by computers. Buell & Pollock	Oct. 20 *147	Jacketing, aluminum	Nov. 3 *76
The story of engineers on strike. Oct. 6 156		Jaw crusher	Sept. 22 204
Technical writing—Today, accuracy demands the first person. E. M. Cortelyou	Nov. 8 *147	Joints, expansion	July 14 *94
There is no undue shortage of engineers June 2 131		Lab, hazardous material	Feb. 10 *98
This knowledge belongs to the employer	Oct. 20 172	Ladder, plastic	Sept. 8 170
This will be your best year... Feb. 24 166		Liquefier, centrifugal	Mar. 24 *84
Three big points of dispute about your job—salaries, moving expenses and "engineer shortage"	Feb. 10 163	Loader, front-end	Jan. 13 104
What's wrong with engineering education. J. R. Killian, Jr., F. H. Rhodes Apr. 21 178		Molds, coextruded	Mar. 10 *88
What makes a successful chemical engineer R. S. Schultz (tables). Mar. 10 171		Meter, flow	Sept. 22 98
You have a key spot in the rocket age May 19 *187		Meter, radiation	Aug. 17 *174
Engines		Mill, dispersion	May 19 *82
Air turbocooler ups gas-engine performance Sept. 8 *80		Mill, dry-grinding	July 14 *94
Coolant tailored to ebullient cooling Nov. 17 86		Mill, impact	Dec. 1 *150
ICBM rocket engines undergo test firing (N)	Sept. 22 *84	Mixer, pipeline	June 20 *76
Equipment		Mixer, steam-water	Aug. 25 *78
Consider buying used equipment. R. R. Imsande	July 14 *141	Mixer, world's largest	Jan. 13 *100
Crystallization—for your next purification problem—report—(tables)	Aug. 11 *125	Motor, D. C.	Dec. 29 *49
How to select an equipment design Aug. 11 124		Motor, electric	Oct. 20 *198
What crystallizers cost today. Aug. 11 138		Motor, giant electric	May 19 *82
Depreciation: there'll be some changes made (charts)	July 28 70	Motor, immersible	Feb. 10 *96
Equipment costs continue upward—Marshall and Stevens annual indexes of comparative equipment costs, 1913-1957 (charts & tables)	Feb. 24 143	Motors, weather-protected	Jan. 21 *82
Estimate cost of graphite equipment John Roys (charts)	Feb. 24 *197	Nozzle, spray	June 13 *102
How to design for radiant heating L. M. Polents (charts & tables) I Apr. 7 137, II Apr. 21 151		Optimizer, process	June 2 *65
		Oscilloscope, recording	Sept. 8 *82
		Pipe, plywood-molded	April 7 *82
		Pipe, stainless-clad	Feb. 10 *100
		Pipe cutter	Sept. 8 *82
		Pipe squeezer	Mar. 24 *84
		Pipe union	Jan. 13 162
		Plasma producer	Oct. 6 *74
		Plastic blanket seals against vapor loss	
		Positioner, valve	May 5 *76
		Power supply	Dec. 15 *210
		Precision amplifier	July 28 *80
		Precision specialties	Aug. 17 *74
		Preheater	Feb. 10 *82
		Pressure equipment	Feb. 24 *80
		Pulper, continuous	Jan. 27 *86
		Pumps, chemical	Jan. 13 102
		Pumps, diaphragm	Oct. 26 *200
		Pump, diffusion	Sept. 22 *209
		Pump, hot	June 30 *74
		Pump, leak-proof	April 21 *82
		Pump, rotary	Nov. 17 *194
		Pump, squeegee	June 2 *65
		Pump, stainless steel	Sept. 8 *171
		Pump, standard	Feb. 24 *86
		Pump, vacuum	Nov. 3 *74
		Pyrometer	May 5 *72
		Radiometer	Sept. 22 205
		Reactor, continuous	Nov. 3 *164
		Reactor, core, portable	Feb. 24 *80
		Recorder, electronic	Aug. 25 *157
		Recorder, end-point	Dec. 15 *96
		Recorder, frequency	Jan. 21 *82
		Recorder, multivibrator	Nov. 3 *74
		Recorder, multipoint	Dec. 29 *101
		Recorder, strip-chart	Dec. 1 *82
		Recording balance charts	
		Rectifier, silicon	Mar. 24 *80
		Regulator, flow rate	Dec. 15 *209
		Regulator, humidity	Oct. 6 *180
		Regulator, pressure	Feb. 10 *98
		Regulator, ratio	Dec. 29 *102
		Regulator, temperature	Nov. 3 *76
		Rescue mask	Jan. 13 102
		Respirator	July 28 *80
			Dec. 1 *148

NOTES—(D.N.) Design Notebook; *Illustrated; (N) News; (P.N.) Plant Notebook

- Rig to convey oil hose..... Aug. 25 *80
 Rotameter..... Dec. 15 *211
 Rubber products..... Mar. 24 *85
 Scale disengagement..... Aug. 11 *100
 Scale conveyor..... Oct. 6 *74
 Screen, enclosed..... Oct. 20 *200
 Screen, pressure..... Apr. 7 *80
 Scrubber..... Apr. 21 *84, May 19 *82
 Scrubber, Doyle..... Feb. 24 *84
 Sealer, emergency..... May 19 *82
 Sensor, liquid-level..... Mar. 24 *82
 Separator, magnetic..... Aug. 11 *172
 Settler, packing..... Feb. 24 *82
 Shower, portable..... July 14 *94
 Shower, safety..... Aug. 19 *94
 Sizing machines, sonic..... Aug. 25 *155
 Silica foamed..... June 30 *74
 Slide rule..... Sept. 22 *208
 Snubber, flow check..... Nov. 3 *168
 Spray gun..... Feb. 10 *98
 Spray head..... Feb. 24 *82
 Springs, air..... May 5 *74
 Sterilizer, continuous..... July 14 *94
 Strainers, start-up..... Feb. 24 *82
 Substation, mobile..... May 24 *194
 Sulfur recovery unit, skid-mounted..... Aug. 25 *80
 Switch, overload..... Sept. 22 *203
 Tank, bulk storage..... Aug. 11 *173
 Tank, rubber-lined..... Dec. 29 *40
 Tanker cover, floating..... July 28 *155
 Telemetering systems..... Dec. 1 *80
 Temperature sensor..... Nov. 3 *74
 Tester, glass..... Oct. 6 *176
 Thermometer, surface..... Jan. 27 *84
 Transducer..... Nov. 17 *194
 Transducer, mass flow..... Dec. 10 *210
 Transmitter, ortameter..... Nov. 17 *182
 Transmitter, pneumatic..... Dec. 1 *80
 Transmitter, remote..... Oct. 20 *202
 Trap, magnetic..... June 30 *74
 Truck, bulk..... Feb. 10 *94
 Truck, detachable-bin..... Sept. 8 *171
 Truck, fork..... June 16 *80
 Truck, lift..... Mar. 10 *98
 Truck, fork lift..... Nov. 3 *164
 Tube, internal-fin..... Jan. 27 *84
 Tubing, pyroceram..... Feb. 10 *196
 Tungsten carbide platelets..... Jan. 27 *85
 Turbocooler..... Sept. *80
 Vacuum sweeper..... Mar. 24 *194
 Valve, all-glass..... Oct. 6 *74
 Valves, aluminum gate..... Jan. 27 *82
 Valve, control..... Oct. 20 *83
 Valves, diaphragm..... Nov. 17 *90
 Valve, fire gate..... Sept. 22 *203
 Valve, gall-free..... Mar. 10 *100
 Valve, glass flush..... May 5 *76
 Valve, high-vacuum..... May 5 *72
 Valve, motor-driven..... Dec. 15 *208
 Valve, plastic ball..... May 19 *80
 Valve, plastic solenoid..... Mar. 24 *194
 Valve, relief..... Sept. 22 *205
 Valve, safety ball..... Aug. 25 *78, Oct. 6 *173
 Valve, shut-off..... Aug. 11 *100
 Valve, slurry..... July 14 *96
 Valve, snap..... Oct. 6 *74
 Valve, throttling..... May 19 *89
 Valve, transfer..... Jan. 27 *86
 Valve operator..... Feb. 10 *100
 Valve packing..... Oct. 6 *76
 Valve positioner..... Sept. 22 *204
 Valve, consider..... Sept. 22 *204
 Vessel, jacketed..... Aug. 25 *82
 Vibrations, bin..... Aug. 26 *154
 Voltage regulators..... Sept. 8 *170
 Water purifier..... Mar. 24 *84
 Welder for gratings..... Mar. 10 *98
 Welder, mobile induction..... Sept. 22 *96
 Wheel stop, safety..... May 6 *74
 Wrench, Hex..... Nov. 3 *78
 Xerography, automatic..... Dec. 29 *100
 X-ray unit..... Dec. 1 *82
 Zipper, filter-bag..... Feb. 10 *100
 Etching printed circuits—Becco process (N)..... Jan. 27 *62
 Ethanol-Solvent blues: It's not just the process..... Aug. 11 *90
 Ethyl benzene-Polystyrene via "natural" ethyl benzene—Corden Petroleum Co.—flowsheet..... Dec. 1 *98
Ethylene
 Ecco's Baton Rouge, La. ethylene plant fire—early evidence hints at bearing failure (N)..... Nov. 17 *72
 Ethylene: technology paints the market picture. J. W. Bradley & others..... Jan. 27 *88
 Perchloroethylene—quick HCl chill highlights new perchloro process—flowsheet..... May 5 *116
 Phillips Petroleum's new ethylene plant adopts data-handling unit (N)..... Aug. 11 *84
 Salt domes may be used for storing ethylene (N)..... Nov. 17 *78
Ethyne Oxide
 GAF backs air-oxidation—flowsheet July 28 *100
 Wyandotte Chemical's new ethylene oxide unit uses oxygen, not air (N)..... June 30 *66
Evaporators—CE Cost File. Harold Gushin, I..... June 16 *187
Explosions—Calculate adequate rupture disk size. J. G. Lowenstein. Jan. 13 *157
Explosives—American Cyanamid completes ammonium nitrate plant at New Castle, Pa. (N). Oct. 20 *72
Extraction
 Cell wrings helium from natural gas (N)..... June 20 *60
 Centrifugal extraction makes uranium debut (N)..... June 20 *60
 Columbium and tantalum—flowsheet Electro Metallurgical Co. Nov. 3 *104
 Electrolytic process for extracting uranium goes into pilot-plant stage (N)..... Jan. 27 *70
 Esso Standard Oil's wax plant—small change nets process dividends—flowsheet Esso Standard Oil's wax plant—small change nets process dividends—flowsheet Esso Standard Oil's wax plant—small change nets process dividends—flowsheet
 For mass transfer—quick method finds optimum trays and reflux ratio. John Happel July 14 *144
 Home washer doubles as pilot extractor. Seltzer & Paxton (D.N.).... Apr. 7 *158
 Mass transfer operations. J. O. Osburn Mar. 24 *145
 Mechanics of mass transfer. Apr. 21 *161
 How to use mass transfer coefficients May 19 *169
 How to modify mass transfer equations June 16 *182
 Find number of theoretical stages July 14 *147
 Transfer unit simplifies calculations Aug. 11 *147
 Mass transfer behavior in fixed beds Sept. 8 *143
 Correlate mass transfer coefficients Oct. 6 *146
 Estimate efficiency in mass transfer Dec. 1 *119
 Nitric bids for role in uranium leaching (N)..... May 5 *62
 Shortcut to uranium fuels—Davidson Chemical's four-story solvent extraction columns—flowsheet Oct. 20 *128
 SX line wins uranium from variety of ores—flowsheet Aug. 25 *104
 Use graph to design for optimum economic extraction. R. S. Olson. Oct. 6 *142
 Extrusions—Continuous vulcanizer cures extrusions fast (N)..... May 5 *80
- F**
- Fans—Chart selects centrifugal fans. E. J. Gibbons (P.N.)..... Jan. 27 *144
Fertilizers
 Acidulation of phosphate rock with nitric acid to make fertilizers being introduced to U. S. by Vitro Engineering Co. (N)..... Nov. 3 *80
 Montecatini revives fertilizer process (N)..... Feb. 24 *84
 Polited fertilizer Dec. 1 *76
²O₂ is making news in fertilizers—TVA's development program (charts & tables) Dec. 29 *32
Fibers
 Cyclone winnows asbestos fibers from dust (N)..... Dec. 15 *82
 Dacron—synthetic skin for blimp Dec. 10 *92
 Inventory of new processes and technology May 5 *62
 Polyester fiber Oct. 20 *82
 Potassium titanate in fibrous form—dead-ends, 2,000 F. heat..... Dec. 15 *90
 Puerto Rico will get synthetic fiber plant (N)..... April 21 *66
 Quartz cloth makes plastic stand up to 5,000 F. Dec. 29 *37
 Symmetrical cross-sections mark new fibers June 2 *37
Filtration
 Cake indicator automates filter. Jan. 13 *12
 Chart finds precoat filter cake time. Stanley Tolm (P.N.)..... Mar. 24 *150
 Eagle-Picher's filter aid plant tarts up (N)..... Sept. 22 *150
 Nitric bids for role in uranium leaching (N)..... May 5 *62
 Operation and maintenance—Continuous and batch filters. G. G. Reed June 16 *160
 Plastic displaces metal in new filter plates June 30 *68
 Rotary filter boasts plastic construction Aug. 11 *98
Finance
 CPI spending plans—Will sagging chemical outlays perk up soon? W. H. Chartener (charts & tables) July 28 *70
 Consider buying used equipment. R. R. Imaande Dec. 15 *84
 Depreciation: there'll be some changes (charts) July 28 *72
 MAPI formula easing modernization decision Aug. 25 *72
 1957—chemical firms score in sales, find profit pickings slimmer. W. H. Chartener (tables) April 7 *86
 Operation and maintenance—How leasing conserves capital. J. Ernest Nachod (tables) June 16 *150
Fire Protection
 Dry ice lumps decrease fire hazard. Barnes & Huber (P.N.).... July 14 *154
 Fire extinguishers use trimethoxy-boronoxine liquid Sept. 8 *78
Fluorocarbons
 High-order flocculant, Polyox, spans wide pH Mar. 24 *74
 Separan 3410 July 28 *74
Flowsheets
 Cat cracker sets challenges—Tidewater Oil's giant Orthoflow fluid catalytic cracking unit Oct. 6 *120
 Cement—preheating cement kiln feed saves Btu's Sept. 22 *146
 Columbium and tantalum—Electro Metallurgical Co. Nov. 3 *104
 Crystallization: key step in sodium sulfate process Aug. 11 *116
 Esso Standard Oil's wax plant—small change nets process dividends—flowsheet Esso Standard Oil's wax plant—small change nets process dividends—flowsheet Esso Standard Oil's wax plant—small change nets process dividends—flowsheet
 Ethylene oxide—GAF backs air-oxidation July 28 *100
 For rockets, tried tactics win solid fuel Apr. 21 *136
 Handy way to scale drawings for flowsheets. R. H. Berg (P.N.).... May 19 *174
 High purity manganese via electrolysis May 19 *174
 Hydrazine via NH₃ today July 14 *130
 Iron recovery demands engineering compromise June 16 *132
 Magnesia from sea via streamlined process Mar. 24 *112
 Magnesia process buttons up sulfite pulping—Brown Co. Sept. 8 *114
 Making giant electrodes: problems magnified too April 7 *128
 Perchloroethylene—quick HCl chill highlights new perchloro process May 5 *116
 Perfume—process-studded plant: key to fragrances Feb. 24 *111
 Polyethylene—high-pressure polyethylene process persists Dec. 29 *42
 Polystyrene via "natural" ethyl benzene Dec. 1 *98
 Rubber—continuous rubber route done a new look June 2 *102
 SX line wins uranium from variety of ores Aug. 26 *104
 Short cut to uranium fuels Oct. 20 *128
 Sodium-reduction route yields titanium Mar. 10 *124
 Sulfur takes over at Spindletop. Nov. 17 *136
 3 materials vie for role as reactor coolant June 20 *96
 Titanium dioxide process taps sorel slag for savings Jan. 27 *92
 Zinc-Ascaro's integrated refinery delivers alloys, too Dec. 15 *123
 Zirconium now sweeps into the big time Jan. 13 *128
Fluids
 CE flow file. Maxey Brooke Pt. XIII Jan. 13 170, Pt. XIV Jan. 27 *140
 Chart converts flow units. J. A. Seiner (D.N.) Oct. 20 *170
 Convenient flow formulas for water in pipes. D. M. Lindemann (P.N.) Feb. 10 *152
 Fluid mixing in tank cars. R. L. Bates Aug. 25 *126
 Hydraulic fluid Oct. 20 *84
 Inverted bottle makes a constant-head feeder. H. Leslie Bullock (D.N.) Oct. 20 *170
 Speed trial and error solution for pipe diameter. Tassoney & Drotter (charts) Sept. 8 *138
 Fluorine—Bell Aircraft harnesses fluorine for rocket propellant use (N) Oct. 6 *52
 Fluorocarbons—new series May 19 *76
 Fluoro-organics April 21 *74
 Glass-reinforced foam May 5 *63
 Urethane foam insulates portable utility hut April 21 *76
 Food chemicals—Potassium sorbate for food use Aug. 11 *94
 Formaldehyde—Montecatini Co.'s formaldehyde route nets high yield, high purity (N) June 20 *62
Fractionating
 Horizontal fractionator looms as potential rival to multistage high vacuum towers (N) Feb. 15 *76
 In nickel process pioneer sulfur distillation (N) April 7 *81
 Polystyrene via "natural" ethyl benzene—Corden Petroleum Co.—flowsheet Dec. 1 *98
 Starch process from Netherlands nudges genetics to sidelines in race to produce amylose (N) March 24 *66
Fuel
 Appleby-Frodsham Steel's fluid bed desulfurizes fuel gas (N).... Oct. 20 *74
 Atom-fuel—use for processing industry? J. A. King Oct. 6 *62
 Atomic power can level regional fuel costs Aug. 25 *72
 Borane fuel process brought into focus (N) June 20 *54
 Boron fuels head for volume output (N) Dec. 15 *76
 Canadian Industries Ltd. new ammonia plant uses fuel oil feed (N).... April 21 *68

Fast-breeder reactor fuel contracts let for Enrico Fermi Atomic Power Plant (N) ... Aug. 25	62	Pontiac Eastern coker-cracker combo hits 80% gasoline yield (N). Apr. 21	*64	Solve time in heat exchanger design	Oct. 20	153
Five-year planners eye Russian designs (N) ... Sept. 23	78	Spend octane dollars on today's know-how (table) ... Oct. 20	78	Tubeside heat transfer coefficient	Nov. 17	155
Fluorine harvests for rocket propellant used (N) ... Oct. 6	58	Germanium		Shellside heat transfer coefficient	Dec. 1	117
Fuel cells may star in satellite power picture (N) ... Dec. 29	*30	Carmen Southern Chemical plant uses home-made rectifiers (N) ... Dec. 1	*56	How to design for radiant heating	L. M. Polenta (charts & tables)	
High-energy fuels head for stratosphere-top technical trend of the year	Jan. 13	Semiconductors point to gains in both production and use—top technical trend of the year ... Jan. 13	140	I—Apr. 7 157, II—Apr. 21	151	
Hydrogenation process developed in Britain converts heavy oil to fuel gas (N) ... Aug. 25	*64	Glass		Low-cost heat transfer with expandable aluminum (N) ... Apr. 7	168	
ICBM rocket engines undergo test firing (N) ... Sept. 22	58	Glass drainlines catch on ... June 16	*196	Revamped kilns smooth lime burning at Chancery Corp. (N) ... July 25	*64	
Nuclear fuel costs? Nobody's sure		Glass paper ... July 28	74	Heat Transfer		
Ohio Standard's giant waste CO boiler saves heat, cuts fumes (N) ... May 5	73	Shock-resistant glass ... July 28	144	Electric oven defrosts enzymatic material	Norman L. Hobbs (P.N.)	
Oil shale, tar sands promise economic fuels (N) ... Nov. 3	58	Glass Fibers		Dec. 29	*66	
Rocket-propellant process—Astrodyne, Inc. solid-propellant plant—flowsheet	Apr. 21	Glass-reinforced foam ... May 5	88	Heat capacity ratios—5 hydrocarbons	Joffe & Delaney (graphs)	Mar. 24
Rockets and missiles—report R. L. Noland (tables) ... May 18	*145-160	Motorboats with hulls of polyester fibrous glass for first Trans-African Waterway Expedition ... Dec. 15	*92	Intense arc pierces temperature barrier (N) ... Dec. 29	*1	
Show off to uranium fuels—Division Chemical's four-story solvent extraction column—flowsheet ... Oct. 20	*188	Nitrogen fixation with glass fibers (N) ... Jan. 27	70	Heating		
Soaring demand for liquid fuels gets assist from fuel solids—top technical trend of the year ... Jan. 13	143	Phenolics beat aircraft heats. June 16	*72	Eductor cuts noise of live steam heating	J. F. Kuang (D.N.)	Aug. 25
Fungicides—Potassium sorbate sources for use as fungistatic agent for foods		Graphite		Infrared lamps stop steel corrosion (N) ... Aug. 25	146	
Furnaces		Colloidal graphite ... Aug. 11	96	Helium-Cell wrings helium from natural gas (N) ... June 30	60	
American Smelting & Refining's copper flows continuously from new arc furnace (N) ... Mar. 10	*75	Estimate cost of graphite equipment		Herbicide, 2, 4, 5-T ... Aug. 11	*94	
Flame oxidizer slashes metallic oxide costs (N) ... Dec. 15	*78	John Reys (charts) ... Feb. 24	*137	Homogenizer, ultrasonic finds many new applications ... Mar. 10	*94	
Giant electrodes manufactured by National Carbon backs trend to huge arc furnaces—flowsheet ... Apr. 7	*128	Giant graphite blocks speed honeycomb production ... Nov. 17	*178	Hydrazine via NH ₃ today—flowsheet	July 14	*120
Solar furnace uses patchwork mirror (N) ... Oct. 20	72	How much life in graphite heat exchangers? C. P. Dillon ... Sept. 22	*184	Hydrocarbons		
G		New coatings boost graphite applications ... Sept. 22	*188	Catalyst key to new chlorination processes (N) ... May 19	66	
Gas		Rotary-kiln reactor uses powdered graphite (N) ... June 2	50	Heat capacity ratios—5 hydrocarbons	Joffe & Delaney (graphs)	Mar. 24
Appleby-Frodingham Steel's fluid bed desulfurizes fuel gas (N) ... Oct. 20	*74	Graphs—How to make and use more effective graphs G. A. Lessells ... July 28	109	Hydrochloric Acid		
Balloons pace gas velocity Lyndon Babcock (P.N.) ... Mar. 24	*148	Hafnium		Hooker Chemical's new scheme cuts HCl purifying cost (N) ... Oct. 6	*60	
Calculate adequate rupture disk size. G. Lowenstein ... Jan. 13	157	Bi-metal-reduction setup wins high-purity hafnium (N) ... Sept. 8	70	Quick HCl chill highlights new perchlor process—flowsheet	May 5	*116
Collecting and sorted numerous samples Brief & Drinker (D.N.) ... Nov. 17	*162	Heat		Hydrogen		
Costs favor hot carbonate process for bulk removal of acid gases. A. G. Eickmeyer (charts & tables) ... Aug. 25	113	Estimate engineering properties W. R. Gambill (charts)		Hydrogenation process developed in Britain converts heavy oil to fuel gas (N) ... Aug. 25	*64	
Dew point gives moisture content of gases. W. H. Fischer (chart) ... May 19	178	Latent heat II—Temperature vs. heat of vaporization ... Jan. 13	159	Pressurized electrolyzer produces hydrogen (N) ... Oct. 6	54	
Estimate engineering properties W. R. Gambill (charts & tables)		III—Predict mixture heat of vaporization ... Feb. 10	137	Stainless industry exploits hydrogen—top technical trend of the year ... Jan. 13	139	
Predict diffusion coefficient D.		IV—Find heat of fusion and sublimation ... Mar. 10	147	Hydrogen Chloride		
Best methods for Prandtl number	June 3	Surface tension for pure liquids ... Apr. 7	146	Hooker Chemical's new scheme cuts HCl purifying cost (N) ... Oct. 6	*60	
Estimate low-pressure gas viscosity	Aug. 25	Predict diffusion coefficient D ... June 3	125	Quick HCl chill highlights new perchlor process—flowsheet	May 5	*116
How T and P change gas viscosity	Sept. 22	Predict liquid diffusivities ... June 30	113	Thermal data for chlorine and HCl. C. J. Dobratz (charts & tables) ... Feb. 10	144	
To get viscosity for a gas mixture	Oct. 20	Best methods for Prandtl number ... Aug. 25	121	Hydrogen cyanide—Boosting temperature boosts yields—Degussa new catalytic process (N) ... Aug. 25	68	
Find gas velocity by ammonia injection. R. L. Johnson (P.N.) ... Dec. 1	126	Estimate low-pressure gas viscosity ... Sept. 22	169	Hydrogen peroxide—Heat content and vapor pressure of hydrogen peroxide. Simkin & Hurd (charts & tables) ... Jan. 13	155	
Fluorine-carbon insulating gas. May 19	76	How T and P change gas viscosity ... Oct. 20	157	Hydrogen sulfide—Largest H2S plant will be part of Freeport Sulphur's nickel-coal mining operation at Moa Bay, Cuba (N) ... Mar. 24	62	
Heat capacity ratios—5 hydrocarbons Joffe & Delaney (graphs) ... Mar. 24	128	To get viscosity for a gas mixture ... Nov. 17	157	Hydrogenation process developed in Britain converts heavy oil to fuel gas (N) ... Aug. 25	*64	
Hydrogenation process developed in Britain converts heavy oil to fuel gas (N) ... Aug. 25	*64	Heat Exchangers		I		
Lazy scrubber at Courtlandt Ltd. knocks out H ₂ S, cuts power cost (N) ... June 20	56	Air-cooled heat exchangers. E. C. Smith (charts & tables) ... Nov. 17	*145	Imports—Freer trade is a two-way street		
Manufactured gas. Frances Arne	Mar. 24	Costs see under "Chemical Engineering Cost File"		India—Shows gain in chemical technology (N) ... Jan. 27	70	
Methylacetylene-propadiene commercially available ... May 19	76	Easy way to optimum exchangers. John Happen ... Sept. 8	135	Inorganic Chemicals		
Nerve gas—Chemical Corps. U. S. Army facilities at Muscle Shoals (N) ... Sept. 22	*74	Heat Exchanger design—calculations. Ning Hsing Chen (charts)		Inventory of new processes and technology		
Now stream analyzers developed at Oak Ridge (N) ... Oct. 20	76	Find tubeside heat transfer coefficient ... June 30	110	Nonflammable organics for severe processing conditions. M. D. Robbins (report) (tables) ... Sept. 8	*123	
Russians will utilize compressed-gas work (N) ... July 23	62	Speed pressure drop calculations ... Sept. 22	160	Insecticides		
Save with direct-draw gas. L. M. Polenta (P.N.) ... Sept. 8	70	Speed heat exchanger computations ... Oct. 6	149	Carbamate insecticide ... Jan. 13	96	
Scrubber ends coker's naphthalene woes (N) ... May 19	*68	Save time in heat exchanger design ... Oct. 20	153	Herbicide, 2, 4, 5-T ... Aug. 11	*94	
Tower reactor speeds multiphase reactions (N) ... July 14	86	Tubeside heat transfer coefficient ... Nov. 17	155	Monsanto safeguards new parathion plant with cordon of safety features (N) ... Mar. 10	*76	
Transparent plastic models reveal answers to gas-flow problems (N) ... Mar. 24	*70	Shellside heat transfer coefficient ... Dec. 1	117	Inspection—illuminated device inspects translucent materials. Cherevitsinoff & Dunkin (P.N.) ... Aug. 11	*153	
Water simulates gas flow in model tests (N) ... Oct. 20	70	How many tubes in an exchanger shell? L. L. Senn (D.N.) (chart) ... Dec. 15	183	Instrumentation		
Gasoline		How much life in graphite heat exchangers? C. P. Dillon ... Sept. 22	*184	Get a seven days' records on a one-day chart. D. C. Williams (P.N.) ... Dec. 1	126	
Dry absorbers now open new sources of gasoline—hydrocarbon recovery from natural gas (N) ... Dec. 13	*72	Let computers pick your exchangers. R. E. Githens Jr. ... Mar. 10	*143	Information retrieval finds it in minutes. M. W. Kellogg Information Retrieval Center (N) ... Dec. 29	*28	
Molecular sieves win higher-octane gasoline at Texas Co. (N) ... Oct. 20	76	Preheating cement kiln feed saves Btu's—Coplay Cement Mfg. Co. flowsheet ... Sept. 22	*146	Mockup for instrument panels. A. J. Waldron (P.N.) ... Jan. 13	*164	
NOTES—(D.N.) Design Notebook; *Illustrated; (N) News; (P.N.) Plant Notebook		Heat Transfer		New optical methods spot hidden corrosion. J. M. Holman ... Apr. 21	*170	
		Chart visualizes heat transfer relations. E. J. Gibbons (D.N.) ... June 2	129	Page-to-deck flow of data hastened by IBM (N) ... July 14	94	
		Heat exchanger design—calculations. Ning Hsing Chen (charts)		Phillips Petroleum's new ethylene plant adopts data-handling unit (N) ... Aug. 11	*84	
		Find tubeside heat transfer coefficient ... June 30	110	Processors step up instrument developments (N) ... July 14	*80	
		Speed pressure drop calculations ... Sept. 22	160	TV computers find new refinery jobs (N) ... Jan. 13	82	
		Speed heat exchanger computations ... Oct. 6	149	Temperature recorder points doubled. R. J. Zellner (P.N.) ... Feb. 24	*154	

- Insulation**
- Inside insulation saves cost. R. F. Benenati (D.N.) May 5 *148
 - Jacketing insulated equipment. J. K. Paul (P.N.) Aug 11 *154
 - Plastic protection for vessel insulation. P. N. Chermisinoff (D.N.) June 30 118
 - Westinghouse insulation makes better insulation & fire (N) Dec 1 *60
 - International Atom-for-Peace Conference—Geneva experience guide to future meetings (N) Dec 1 70
 - International Symposium on Plastic Testing and Standardization to be held Oct. 30–31, 1958. Oct 6 162
- Ion Exchangers**
- Drug maker runs ion column on thick broth (N) June 2 *54
 - Moving beds double ion exchange capacity at Lucky Mcuranium Corp., Riverton, Wyo. mill (N) Sept 22 *80
 - Staley wings phytic acid from waste corn steep liquor with ion exchange (N) Jan 27 *81
 - Styrene-based cation exchange resin lasts longer. May 19 *74
- Iron**
- Electric smelting step wins high-purity iron (N) Nov 3 64
 - International Nickel Co. iron recovery demands engineering compromises—flowsheet. June 16 *132
 - New wrought iron shows superior resistance (N) Mar 24 *156
 - Rotary kiln enters iron-ore reduction race (N) May 5 *52
- Isothalic**
- California Research Corp.'s piloting sparks Isothalic's market drive (N) Nov 17
 - Isothalic acid in paint. June 2 *60
 - Isothalic's dehydrogenation process opens up new avenues to isoprene (N) Aug 26 63
- K**
- Ketones—Solvent blues: it's not just the recession. Aug. 11 90
- Kettles**
- CE Cost File II Cost of process vessels Harold Gushin (charts) July 14 158
 - CE Cost File VIII—Fixed tube sheet exchangers and kettle reboilers. H. P. De Lamater. Dec. 15 181
 - Current costs of vessels and motor reducers—CE Cost File IV. Harold Gushin Sept 8 141
- Kilns**
- Fluid-bed under trial regenerating carbon (N) Dec 1 *62
 - Preheating cement kiln feed saves Btu's. Coplay Cement Mfg. Co. flowsheet. Sept 22 *146
 - Revamped kilns smooth lime burning at Chemstone Corp. (N) July 23 *64
 - Rotary kiln enters iron-ore reduction race (N) May 5 *52
- Kinetics
- How to scale up pilot plant data and equipment—report. E. L. Clark (charts) Oct 6 *129
 - How to set up the necessary mathematics. Ball & Johnson. Fit differential equation to standard form. Jan 27 135
 - Solve second-order linear equations Feb 24 145
 - Kneaders—CE Cost File Harold Gushin I June 16 187
- L**
- Labor**
- Britain's Bd. of Trade rejects plan to build nylon plant near Portsmouth because unemployment rate is higher at several alternative sites. Nov 17
 - Chemical unions may merge in 1958 (N) Oct 26 80
 - Coffee breaks. Mar 10 174
 - Get a job from the man who owns one: the interviewer. R. J. Obrochts. Apr 15 *184
 - It's true: the man can make the job! Apr 21 179
 - Mental fatigue can sabotage your success. P. W. Matman. June 16 181
 - More politics for chemical people? Nov 17 82
 - NLRB rules on chemical assistants Apr 21 180
 - Operation and maintenance—Technical service groups. R. D. Barnard June 16 *144
 - Should your employer pay you overtime? R. D. Stevens. Dec 1 127
 - Train your own instrument men Brigham & Kunz. Nov 17 *168
 - Youth wants to work. Jan 13 184
- Lead**
- Automatic lead cladding slashes costs June 30 *122
 - Lead slag gives low-cost radiation housing (N) Jan 27 80
- Lime**
- Revamped kilns smooth lime burning at Chemstone Corp. (N) July 23 *64
 - United States Lime Products Corp. new lime-processing plant vies for western markets (N) Aug 11 *82
- Liquids**
- Gas relative volatility for binary solutions. R. F. Sweeny (D.N.) May 6 148
 - Handling volatile liquids from storage Douglas MacGregor (P.N.) Mar 10 *158
 - How to estimate engineering properties W. R. Gambill see under Engineering Level measurement in frothing liquids. J. A. Seiner May 19 *178
 - New data supplement liquid viscosity chart. J. A. Seiner (D.N.) Sept 22 176
 - Nomograph gives settling velocity. M. Rhoden (P.N.) May 10 160
 - Old trick averts error in figuring dilution. W. H. Fischer (P.N.) Sept 8 149
 - Solve batch liquid metering problems with a volumetric tank Max Bass Oct 20 *150
 - Tower reactor speeds multiphase reactions (N) July 14 86
 - Literature—Searchers seek to open literature logjam. Feb 10 *84
- Lubrication**
- Grease, Mobilplex EP. June 16 74
 - Lubricate under corrosive conditions (chart). Feb 10 154
 - Shell Oil's better deasphalting keys lube-oil setup (N) Nov 8 *54
- M**
- Magnesia**
- Brown Co.'s magnesia-base pumping breaks pollution stalemate (N) Sept 8 *60
 - Brown Co.'s magnesia process buttons up sulfur pulping—flowsheet Sept 8 *114
 - Magnesia from sea via streamlined process—flowsheet. Mar 24 *112
 - More seawater magnesia slated for production (N) Oct 6 60
 - Magnesium methoxide. Jan 27 78
- Maintenance**
- Corrosion—refresher on cause and cure see under Corrosion
 - Dust collectors—troubleshooting. W. E. Archer. Dec 15 *188
 - Emergency repair is permanent Buckley Sullivan (P.N.) Feb 4 *154
 - How much life in graphite heat exchangers? C. P. Dillon. Sept 22 *184
 - "Internal seal pots" eliminate gage plugging. L. E. McLane (D.N.) June 30 *117
 - Maintenance zooms as automation gains—top technical trend of the year. Oct 10 144
 - Map your protective coating program. Dow's prevention program. Feb 10 *125
 - Operation and maintenance—report June 16 *141-181
- I Industry trends in O & M. Technical service groups. R. D. Barnard June 16 *144
- Rise of contract maintenance. Raphael Katzen. June 16 *146
- How leasing conserves capital. J. Ernest Nachod. June 16 *150
- II Select and design for O & M. Operations define dryer design. P. Y. McCormick. June 16 *154
- Continuous and batch filters. Glen R. Reed. June 16 *160
- Materials handling equipment. Murray & Howe. June 16 *164
- Thickeners and clarifiers. Glenn O. Wilson. June 16 *168
- Improve agitator performance. H. W. Dutton & others. June 16 *172
- Chemical process pumps. R. R. Rhodes. June 16 *178
- Optimize your maintenance stores. R. E. Bley (chart). Oct 20 174
- Plastic metal minimizes plant shutdowns. June 16 *150
- Quick trick for a water line repair. H. G. Knapp (P.N.) May 19 176
- Rate economic factors by importance. Kenneth Finlayson. Jan 13 151
- Reduce your maintenance costs. G. C. Derrick. July 23 132
- Results of maintenance survey Nov 17 172
- Salvage operation saves 1,000 steel nozzles. Sept 22 *186
- Teflon caulkings prevents leaks in threaded joints. R. A. Snedeker (P.N.) Oct 6 154
- Tips on maintaining stainless steel ware. P. C. Ziemke (P.N.) Nov 8 146
- Train your own instrument men. Brigham & Luntz. Nov 17 *168
- Weighted thermocouple helps installation. J. F. Kuong (P.N.) July 14 *151
- Management**
- Brainstorming: now it can work for you. J. G. Mason. July 14 158
 - Does your employer own your knowledge?—recent legal decisions July 23 *127
 - How "Dear Boss" letters spawn creativity. Carl Pacifico. Jan 18 *181
 - How to cope with water pollution problems—report. July 14 *129-140
 - How to make a speech. Mar 10 174
 - How to measure individual performance. R. G. Trout. Sept 22 173
 - How to measure management performance. Chaplin Tyler. June 20 119
 - How to run an effective meeting. W. L. Knighton. Jan 27 *157
 - How to start a standards program. Brand & Sisler. Feb 10 141
 - It's true: the man can make the job April 21 179
 - Mental fatigue can sabotage your career. P. W. Matman. June 16 181
 - More politics for chemical people? Nov 17 82
 - Rate economic factors by importance. Kenneth Finlayson. Jan 13 151
 - Should your employer pay you overtime? R. D. Stevens. Dec 1 127
 - Six sure steps to the top. O. A. Battista Feb. 24 *166
 - Technical writing—Today, accuracy demands the first person. Ethelma Cortelyou. Nov 9 *147
 - What makes a successful chemical engineer. R. S. Schultz (tables) Mar 10 171
- Manganese**
- High-purity manganese via electrolysis—flowsheet. May 19 *136
 - Udy ferromanganese gets commercial nod (N) Jan 13 86
- Marshall and Stevens comparative equipment costs—annual indexes 1913 to 1957 (charts & tables). Feb 24 143
- Marshall and Stevens index of comparative equipment costs (tables)
- Jan 10-19. Jan 27-82. Feb 10-100. Feb 24-82. Mar 10-96. Mar 24-86. Apr 7-84. Apr 21-80. May 5-76. May 18-84. June 2-70. June 18-80. June 30-75. July 14-96. July 28-154. Aug 11-78. Aug 16-158. Sept 8-174. Sept 22-215. Oct 6-184. Oct 20-204. Nov 3-170. Nov 17-193. Dec 1-154. Dec 15-214. Dec 29 103
- Mass Transfer Operations see under "Chemical Engineering Refresher"
- Materials Handling**
- Adjustable platform aids material loading. E. J. & C. A. Erwood (P.N.) Mar 10 158
 - Build a dust hood for drum filling P. R. Wiewandt (P.N.). Apr 21 *166
 - Build a dust-and water-tight unloader. O. D. Dressel (P.N.). June 16 *183
 - Bulk carriers with built-in pneumatic handling systems. Feb 10 *94
 - Bulk station show-off easy sodium handling at Mallory-Sharon Metals (N) June 16 *63
 - California and Hawaiian Sugar Refining Corp. mechanizes loading job (N) Nov 17 *72
 - Handling drums without pallets (P.N.) Oct 6 *155
 - Handling volatile liquids from storage Douglas MacGregor (P.N.) Mar 10 *158
 - Heavy handling trick for plant shops Buckley Sullivan (P.N.) Jan 27 *144
 - Mobile two-way radio network assists in materials handling at J. T. Baker Chemical (N). Jan 27 *68
 - Molded urethane, the precise packing material for delicate cargo. See 8 *76
 - New hopper prevents bin stoppage. Apr 7 *78
 - Operation and maintenance—Materials Handling equipment. Menary & Howe. June 16 *164
 - Pneumatic conveying setup handles polyethylene at Phillips Chemical Co. (N) Sept 8 *66
 - Reactive silicon travels safely in polyethylene lined containers. May 8 *66
 - Union Tank Car Co. dome speeds up materials handling (N). Nov 8 *58
 - Unit loads trim cost of moving construction materials to Union Carbide Chemicals' new plant site (N) May 19 *64
- Materials of Construction
- Above 2,500 F. what material to use? I. D. Loch (tables). June 30 *105
 - Automatic lead cladding slashes costs June 30 *132
 - Back to fundamentals (N). Aug 25 146
 - Cermetts for 2,200 F. and above Sept 22 183
 - Columbium ingots now possible Dec. 15 *198
 - Ductile ceramics (N). Apr 21 196
 - Ductile vanadium. Dec. 15 *196
 - 18th biennial report. Dec. 15 *137-176
 - High-temperature metals. E. N. Skinner Jr. (charts & tables). Dec. 15 *187
 - Directory of manufacturers. Dec. 15 148
 - Inventory of literature. Dec. 15 171
 - Epoxy-glass laminates. Noch & Codfer. Jan 27 *148
 - Fluorocarbon plastics take on new jobs. Aug 11 *158
 - Foamed silica: hard-to-beat properties (table). Aug 25 142

Index to Vol. 64, January to December 1958

- Fusion brings need for tougher linings (N) Apr. 7 *66
- High-temperature nonmetallics—W. Brown-report (charts & tables) Apr. 21 *125-160
- How to select best plastic for tanks—W. Reybold Mar. 24 *152
- Nonmetallic inorganics for severe processing conditions-report M. D. Robin (tables) Sept. 8 *123-124
- Plastic panel coverings: handle tough plant conditions P. N. Cheremisloff (tables) May 5 *152
- Polyethylene for coating equipment (table) Sept. 8 *153
- Right material cuts pump composition E. R. Drabos May 19 *162
- Rockets and missiles—report R. L. Noland (tables) May 19 *145-160
- Stainless D319 better than type 316 (table) Dec. 15 *194
- Steel—new alloy steel beat process bugaboos Roach & Hall (tables) I—May 19 180 II—June 2 184
- Technology puts the heat on construction materials—top technical trend of the year Jan. 13 140
- Titanium—high-temperature alloy developed Dec. 15 198
- What do you use at 20,000 F? Dec. 15 196
- Zirconium is more popular than ever for nuclear reactors Nov. 17 174
- Mathematics—How to set up the necessary mathematics Ball & Johnson Fit differential equation to standard form Jan. 27 125
- Solve second-order linear equations Feb. 21 145
- Measurements**
- Avoid trouble in using your Parshall flume Crocker & Campbell (P.N.) Nov. 3 *145
- Eliminating air bubbles in measuring density S. N. Srivastava (P.N.) Feb. 10 150
- Film tells flame temperature (N) Jan. 10 *64
- Level measurement in frothing liquids J. A. Seiner May 19 *178
- New stream analyzers developed at Oak Ridge (N) Oct. 20 76
- Solve batch liquid metering problems with a volumetric tank Max Bass Oct. 20 *150
- Mercury—Radioisotopes measure mercury inventory at Australian chlorine plant (N) Sept. 8 *64
- Metallurgy**
- Atomic-age metal extraction—report L. W. Coffey (charts) Jan. 27 *107-122
- Hydrometallurgy new path to profit (N) Jan. 27 70
- Pressure leach purges arsenic from ore—cobalt via Sill process (N) Jan. 13 80
- Metals**
- Alloys from oxides: new process promise (N) June 16 62
- Atomic-age metal extraction—report L. W. Coffey (charts) Jan. 27 *107-122
- Berryllium, next wonder metal? Feb. 10 158
- Cermets for 2,200 F. and above Sept. 22
- Chemical milling of tough metals (N) Apr. 7 62
- Columbium and tantalum—flowsheet Electro Metallurgical Co. extraction Nov. 3 *104
- Columbium ingots now possible Dec. 15 *198
- Ductile vanadium: new material of construction? Dec. 15 *196
- Dysprosium metal June 2 60
- Formed metals studied as smog deterrents (N) Aug. 11 82
- Hydrometals, Inc. oxide reduction process ready to go commercial (N) Dec. 1 60
- Inventory of new processes and technology May 5 130
- Materials of construction 18th biennial report—High-temperature metals E. N. Skinner Jr. (charts & tables) Dec. 18 137
- Metal bellows made from Inconel Feb. 10 158
- Metal supplies: more than enough at last C. H. Chilton (charts) June 20 *78
- Niobium metal—growing interest Jan. 13 174
- Nonoxidative corrosion—where equipment carries molten metal R. J. Jelinek Dec. 29 *56
- Organotins gird for growth period—Metal & Thermit Corp.'s new Carrollton, Ky. facility (N) Aug. 11 *78
- Plastic metals minimize plant shutdowns Nov. 3 *159
- Tantalum developments Jan. 13 176
- Meters**
- Corrosion meters: quick way to optimum inhibitor Dec. 29 *74
- Measure gas temperatures with a flow meter D. S. Scott (D.N.) (chart) Nov. 17 161
- Meter without orifice handles small flows C. M. Fair (P.N.) Oct. 6 *154
- Quick calibration for small gas flowmeters Kunkle & Pai (D.N.) Apr. 7 *160
- "Quickle" substitute for a venturi meter G. L. Head (P.N.) Dec. 1 *126
- Simple flowmeter handles small liquid flows R. G. Bierbower (P.N.) Feb. 10 *152
- Temperature recorder points doubled R. J. Zellner (P.N.) Feb. 24 *154
- Methane—Hydrogenation process developed in Britain converts heavy oil to fuel gas (N) Aug. 25 *64
- Methanol**
- First U. S. Inventa methanol plant (table) Feb. 24 *62
- Solvent blues: it's not just the recession Aug. 11 90
- Methylacetylene-propadiene commercially available May 19 76
- Methyl borate—Widely miscible, non-aqueous solvent, intermediate Dec. 29 36
- Missiles**
- Fuel cells may star in satellite power picture (N) Dec. 29 *30
- Rockets and Missiles—report R. L. Noland (tables) May 19 *145-160
- Mixing**
- Fluid mixing in tankcars R. L. Bates Aug. 25 *136
- Nomograph for turbulence mixers J. G. Lowenstein (charts) Apr. 7 141
- Models**
- Humble Oil & Refining's model refinery operates inside giant computer (N) Feb. 24 72
- Mockup for instrument panels A. J. Waldron (P.N.) Jan. 13 *164
- Plastic model cat reformer aids reactor design (N) Feb. 10 *78
- Transparent plastic models reveal answers to gas-flow problems (N) Mar. 24 *70
- Water models used to design turbines (N) Dec. 29 *27
- Water simulates gas flow in model tests (N) Oct. 20 70
- Modernization**
- MAP formula eases modernization decision Aug. 25 72
- Plan '59—Modernize now for growth and profits Aug. 25 72
- Special report on CPI modernization in '59 tables Nov. 3 *113-144
- How modern is American industry? Nov. 3 *118
- Modernization, why and when Nov. 3 *117
- Team effort diagnoses obsolescence McClaine & Schrier Nov. 3 *128
- New equipment spurs process progress Nov. 3 *131
- Five cases for modernization Nov. 3 *139
- Molding—Slush molding slated for polyethylene use (N) June 16 62
- Molybdenum—Coating processes deposit molybdenum July 14 164
- Molybdenum seed treatment can up legume crop 50% Dec. 29 37
- Motors**
- Insulation makes motor indifferent to flames (N) Dec. 1 *60
- Motor capacitors can be rejuvenated P. C. Ziemke (P.N.) Jan. 27 *142
- Munitions—Nerve gas—Chemical Corps. U. S. Army facilities at Muscle Shoals (N) Sept. 22 *74
- N**
- Naphthalene—Scrubber ends coker's naphthalene woes (N) May 19 *68
- National Assn. of Corrosion Engineers—14th annual conference and exhibit scheduled Feb. 10 158
- Natural Gas**
- Canadian pipeline planned for gas by-products (N) Aug. 25 62
- Cell wrings helium from natural gas (N) June 30 60
- Coal methanation ideas—Researchers at Columbia Univ. applying atomic radiation Australians use fluidized-bed hydrogenation process (N) Mar. 24 64
- First U. S. Inventa methanol plant converts natural gas to pentane-tritol (N) Feb. 24 *62
- French plant to make sulfur from sour gas (N) May 19 *72
- Hydrocarbon recovery from natural gas—dry adsorbers open new sources of gasoline (N) Dec. 16 *72
- Inventory of new processes and technology May 5 131
- Manufactured gas—which process will be used to supplement natural gas? Frances Arne Mar. 24 *121
- Nickel**
- Inco nickel process pioneers sulfur distillation (N) Apr. 7 *61
- Inco process gets pure nickel from NiS—sulfide anode cancels sinter and smelt (N) Apr. 7 *60
- Iron recovery demands engineering compromises—Inco flowsheet June 16 *122
- "New" nickel hard but flexible (N) Apr. 7 *168
- Nickel-lined chemical barges Jan. 13 176
- Niphos chemical process plates resistant nickel Jan. 13 *172
- Nickel-cobalt mining operation at Moa Bay—largest H₂S plant will be part of operation (N) Mar. 24 62
- Niobium—Output rising, price cut in view? (N) Sept. 8 64
- Nitric Acid**
- Addition of phosphate rock with nitric acid to make fertilizers being introduced to U. S. by Vitro Engineering Co. (N) Nov. 3 *60
- Hercules Powder process chops cost of concentrating nitric (N) July 28 62
- Nitric bids for role in uranium leaching (N) May 5 62
- Novel reoxidation scores nitric acid gains (N) July 28 *55
- U. S. Steel's nitric plant optimized at medium pressure (N) May 5 *56
- Nitrogen**
- Glass fibers for nitrogen fixation (N) Jan. 27 70
- Nitrogen compounds Aug. 11 96
- Nomographs**
- Calculate fractional powers by chart Bernard Liss (D.N.) June 30 118
- Chart finds precoat filter cake time Stanley Tolin (P.N.) Mar. 24 150
- Nomograph gives steam pressure vs. air Y. P. Varshni (D.N.) June 2 130
- Make a nomograph to find condensate film temperature Rodriguez & Smith Mar. 19 150
- Nomograph for turbulence mixers J. G. Lowenstein (charts) Apr. 7 141
- Settling velocity nomograph (P.N.) M. Rhoden Mar. 10 160
- Unusual graph papers and their uses G. A. Lessells Aug. 11 141
- Nylon**
- Film—nylon-6 Sept. 23 *94
- Granules for extrusion of large shapes July 14 90
- Neoprene-nylon bubble shields tank cars July 28 *74
- Nylon 6 for process applications D. L. Duncan Dec. 1 *130
- O**
- Obsolescence—Special report on CPI modernization in '59 see under Modernization
- Oils and Fats**
- Metallic stearates Nov. 3 70
- New tall-oil plant reflects refining know-how (N) Aug. 25 *58
- White mineral oil will be of use to plastic manufacturers June 2 60
- Olefins—Silver fluoroborate scrubbing solution separating olefins (N) Sept. 22 82
- Optimum worksheets C. H. Li (charts & tables) April 7 151
- Organic Chemicals—Inventory of new processes and technology May 5 126
- Organotins—Metal & Thermit Corp.'s new Carrollton, Ky. facility (N) Aug. 11 *78
- Oxidation**
- American Cyanamid's new anthracquinone unit to use direct oxidation (N) June 16 70
- Flash oxidation slashes metallic oxide costs (N) Dec. 15 *78
- GAF backs air-oxidation for ethylene oxide—flowsheet July 28 *100
- Hydrazine via NH₃ today—flowsheet July 14 *120
- New waste disposal process—wet oxidation F. J. Zimmerman (charts) April 7 151
- Stainless Aug. 25 *117
- Novel reoxidation scores nitric acid gains (N) July 28 *55
- Pressure leach purges arsenic from ore cobalt via Sill process (N) Jan. 13 80
- U. S. Steel's nitric plant optimizes at medium pressure (N) May 5 *56
- Oxygen**
- Air Products Inc.'s new oxygen route via on-site honors (N) June 16 *66
- Clues gathered in Carbide explosion (N) June 16 62
- Portable oxygen plants will aid missile mobility (N) Jan. 13 90
- Steel firms, Pittsburgh Steel and Detroit Steel, to get on-site oxygen units (N) April 21 62
- Ozone—Boeing Airplane's Wichita, Kan. plant installation proves ozone counters waste cyanide's lethal punch (N) Mar. 24 *62
- Packaging:**
- Capable packaging process encapsulates liquids or solids at low cost (N) Jan. 13 *88
- Molecular sieves tame volatile liquid catalyst into a convenient paste, easy to market April 7 *72
- Polyester film, Videne April 7 *74

- Packing—How to solve soft packing problems. Walter Cooley.....Jan. 27 *131
- Paints:**
- Acrylic paint emulsion.....Mar. 24 76
 - Aircraft paints.....Oct. 6 70
 - Alkyd emulsion affords water-thinned alkyd benefits.....Feb. 10 90
 - Aluminum paint.....June 30 66
 - Chlorinated rubber paints.....Oct. 6 70
 - Graphite-silicone paint.....May 5 66
 - Iso-phthalic in paint.....June 2 60
 - Latex paint for outdoor use.....Apr. 21 74
 - Maintenance paint gives one coat protection (N).....Apr. 7 168
 - Metal protective paint.....Oct. 6 70
 - PVAc-based paint.....Nov. 3 70
 - PVAc-based paints no longer water proof.....June 19 96
 - PVAc paints based on new formulation for outdoors.....Apr. 21 74
 - Resin emulsion paint vehicle.....Aug. 11 94
 - Special coatings will resist spillage. R. Cushing (table).....Feb. 26 156
 - Water-base paint gets first use in auto body priming.....Apr. 7 76
- Patents:**
- Is our patent system obsolete? Aug. 11 156
 - Review patent fundamentals—report G. Crook.....Feb. 24 *121
 - Pentaerythritol—Pentaerythritol U. S. Imports methanol plant converts natural gas to pentaerythritol (N).....Feb. 24 *62
 - Percchloryl fluoride—New rocket fuel oxidizer.....Sept. 22 92
 - Perfume—Process-studded plant: key to fragrances—flowsheet.....Feb. 24 *112
 - Pesticides—Pesticides figure on boost from Soil Bank. Melvin Goldberg (chart & table).....Feb. 10 *102
 - Petrochemicals:
 - More aromatics from petroleum (tables).....May 5 78
 - Petrochemical series. J. W. Bradley & others (tables).....Pt II Ethylene.....Jan. 27 *88
 - Pt III Propylene.....Feb. 24 88
 - Pt IV Butylene.....Feb. 24 92
 - Petrochemicals spur boosts Japan's economy (N).....Nov. 17 76
 - Viktor Petroleum launches into petrochemicals (N).....July 23 *82 - Petroleum:**
 - American Oil Co.—second Ultraformer on stream at Texas refinery (N).....Aug. 11 *88
 - Hancock Oil Co.'s refinery blaze blamed on overflowing dike (N).....June 20 60
 - Hydrogenation process developed in Britain converts heavy oil to fuel gas (N).....Aug. 26 *64
 - Inventories of new processes and technology.....May 5 131
 - Isomerizing steps up bites deeper into C's (N).....Dec. 1 66
 - More aromatics from petroleum (tables).....May 5 78
 - Ohio Standard's giant waste CO boiler saves heat, cuts fumes (N).....May 5 88
 - Oil hydrogenation wins role in new gas plant in England (N).....July 28 66
 - Oil in 1958—Petroleum feels the pinch. J. B. Bacon (charts & tables).....Mar. 24 88
 - Oil shale, tar sands promise economic fuels (N).....Nov. 3 58
 - Oil refiners again boost gasoline octane quality (N).....July 28 68
 - Pontiac Eastern coker-cracker combo hits 90% gasoline yield (N).....Apr. 21 64
 - Refiners must change their yield patterns—bigger share for middle distillates and fuel oil (tables).....Nov. 3 66
 - Refinery calciner gives A-grade petroleum coke (N).....Feb. 24 64
 - Shell Oil's better desulphurizing keys lube-oil setup (N).....Nov. 3 54
 - Splitting by permeation boasts commercial worth (N).....June 2 50
 - Tidewater Oil's giant Orthoflow fluid catalytic cracking unit—Cat cracker sets challenges—flowsheet.....Oct. 6 120
 - U.S.-built unit gives twist to French refinery (N).....Aug. 24 *68
 - Phenol—*p*-tert-butylphenol—substituted phenol.....Dec. 15 90
 - Phosphate—Articulation of phosphate rock with nitric acid to make fertilizers being introduced to U. S. by Vitro Engineering Co. (N).....Nov. 3 *60
 - Phosphine—Tri-n-butyl phosphine. Nov. 3 70
 - Phosphoric acid— P_2O_5 in making news in fertilizers—TVA's development program (chart & table).....Dec. 29 *92
 - Phosphorus—Nerve gas—Chemical Corps. & Army facilities at Muscle Shoals (N).....Sept. 22 74
 - Photodrawings—Let photography speed your drafting. Hammond & Kinstler.....May 19 *161
 - Photography:**
 - Film tells flame temperature (N).....Jan. 27 *64
 - Let photography speed your drafting. Hammond & Kinstler.....May 19 *161
 - Photographs guide growth of better crystals (N).....June 30 *58 - Phthaloyl chlorides.....June 20 66
 - Phytic acid—Staley wrings new byproduct from waste corn steep liquor with ion exchange (N).....Jan. 27 *61
 - Pipes:**
 - Canadian pipeline plan could increase early output of sulfur from gas-stripping operations.....Dec. 15 86
 - Canadian pipeline planned for gas by-products (N).....Aug. 25 62
 - Drilling rubber-lined pipe under vacuum. Foster Franks (P. N.).....Feb. 24 *152
 - Easy way to fabricate elbows. C. A. Lee (D. N.).....July 23 *125
 - Eddy current brake bridles sodium flow (N).....May 19 *66
 - Emergency leak repair is permanent. Buckley Sullivan (P. N.).....Feb. 24 *154
 - Flange-inserted thermowell easy to install. Robinson & Allen (P. N.).....Dec. 1 *125
 - Glass drainlines catch on.....June 16 *196
 - Pipelines now delivering solids—top technical trend of the year.....Jan. 12 142
 - Pittsburgh Consolidation Coal slurry setup readies coal for pipeline (N).....Oct. 6 *54
 - Polyethylene pipe links two plants.....Jan. 27 *152
 - Quick trick for a water line repair. H. G. Knapp (P. N.).....May 19 176
 - Rubber-plastic for hot water pipe.....Jan. 27 76
 - Rule-of-thumb finds water pipe size. William Resnick (P. N.).....July 14 154
 - Speed trial and error solution for pipe diameter. Tascony & Droter (charts).....Sept. 8 188
 - Steam trace for glass pipe. Scace & Fried (P. N.).....AUG. 11 *152

Plant Notebook:

 - Acid resisting cements cure scaling problems. P. C. Ziemke.....Jan. 13 168
 - Adjustable platform aids material loading. E. J. & C. A. Erwood.....Mar. 10 *158
 - Air-excluding constant feeder. T. J. Dixon.....Jan. 27 *142
 - Avoid excess dilution in recovering condensates. J. A. Seiner.....Dec. 28 *66
 - Avoid trouble in using your Parshall flume Crocker & Campbell.....Nov. 8 145
 - Balloons pace gas velocity. Lyndon Babcock.....Mar. 24 *148
 - Build a dust hood for drum filling. P. R. Wiedenb....Apr. 21 *166
 - Build a dust- and water-tight unloader. O. D. Dressel.....June 16 *139
 - Calculate height of a fluidized bed. Francis & Carbone.....Mar. 10 158
 - Chart finds precoat filter cake time. Stanley Tolm.....Mar. 24 150
 - Chart finds composition of ash. E. Gibbons.....Jan. 27 144
 - Collect samples proportional to varying flow. Stepnaski & Smith.....July 14 *152
 - Convenient flow formulas for water in pipes. D. M. Lindamood.....Feb. 10 152
 - Cutting corrosion in refrigerant drying. J. A. Seiner.....Dec. 1 *126
 - Dew point gives moisture content of gases. W. H. Fischer (chart).....May 19 178
 - Drilling rubber-lined pipe under vacuum. Foster Franks.....Feb. 24 *152
 - Dry ice lump decreases fire hazard. Barnes & Huber.....July 14 *154
 - Easy silver plating for copper bus bars. Richard Minser.....Jan. 13 168
 - Electron oven defrosts enzymatic material. N. L. Hobbs.....Dec. 29 *66
 - Eliminating air bubbles in measuring density. S. N. Srivastava.....Feb. 10 150
 - Emergency leak repair is permanent. Buckley Sullivan (P. N.).....Feb. 24 *154
 - Find gas velocity by ammonia injection. R. L. Johnson.....Dec. 1 126
 - Flange-inserted thermowell easy to install. Robinson & Allen.....Dec. 1 *125
 - Gases replace manometer in an emergency. J. F. Kuong.....Aug. 11 *154
 - Get a seven days' records on a one-day chart. D. C. Williams.....Dec. 1 126
 - "Glass-sandwich" resin can join metals. Steve Mazilaukas.....Aug. 11 152
 - Handling materials without pallets. Oct. 6 *155
 - Handling volatile liquids from storage. Douglas MacGregor.....Mar. 10 *158
 - Handy way to scale drawings for flowsheets. R. H. Berg.....May 19 174
 - Heavy handling trick for plant shops. Buckley Sullivan.....Jan. 27 *144
 - How to control flow of rapid-settling slurries. C. W. Roos.....Jan. 13 *168
 - Illuminated device inspects translucent materials. Chernomisoff & Durkin.....Aug. 11 *153
 - Inlet deflector reduces wear and corrosion. J. A. Seiner.....Oct. 6 *154
 - Jacketing insulated equipment. J. K. Paul.....Aug. 11 *154
 - Level measurement in frothing liquids. J. A. Seiner.....May 19 *178
 - Make a easy-to-build butterfly valve. C. A. Lee.....Mar. 10 *156
 - Motor without orifice handles small flows. C. M. Fair.....Oct. 6 *154
 - Mockup for instrument panels. A. J. Waldron.....Jan. 13 *164
 - Motor capacitors can be rejuvenated. P. C. Ziemke.....Jan. 27 *142
 - Nomograph gives settling velocity. M. Rhoden.....Mar. 10 160
 - Null device controls pulp consistency. Melvin Klimm (chart).....Jan. 14 *152
 - Old trick averts error in figuring dilution. W. H. Fischer.....Sept. 8 *149
 - One slide rule setting finds solids dilution. Merton Allen.....Apr. 21 163
 - Percent-time predicts process end. Herbert Borsvold (chart).....Jan. 13 166
 - Phase separator used for preferential sampling. Klimm & Ryon.....Mar. 24 *148
 - Pneumatic conveyor cools hydrated crystals. R. W. Moors.....Nov. 8 *146
 - Quick trick for a water line repair. G. C. Napier (chart).....Oct. 6 *176
 - Quicker temperature conversions—comes from readers.....May 19 176
 - "Quickie" substitute for a venturi meter. G. L. Head.....Dec. 1 *126
 - Reliability of a simple approximation. D. S. Davis (chart).....Feb. 10 150
 - Robot operator for fire door. P. C. Ziemke.....Aug. 11 *152
 - Rule-of-thumb finds water pipe size. William Resnick (chart).....July 14 184
 - Sample for activities in wet gas streams. J. W. Thomas.....Feb. 10 *148
 - Sieve with direct-fired gas. L. M. Polentz.....Sept. 8 160
 - Simple statistics beats blend problem. L. E. Louraine.....Apr. 21 *166
 - Simplified siphon also holds its prime. C. F. A. Roberts.....Dec. 29 *66
 - Steam trace for glass pipe. Scace & Fried.....Aug. 11 *152
 - Tank siphon never loses prime. C. F. A. Roberts.....Oct. 6 *153
 - Teflon caulking prevents leaks in threaded joints. R. A. Snedeker.....Oct. 6 154
 - Temperature recorder points doubled. R. J. Zellner.....Feb. 24 *154
 - Tip on maintaining stainless steel tanks. P. C. Ziemke.....Nov. 8 146
 - Use specific gravity like mobility. C. L. Murray.....Oct. 8 155
 - Water-still controls itself automatically. H. Leslie Bullock.....Dec. 29 *65
 - Weighted thermocouple helps installation. J. F. Kuong.....July 14 *154

Plants:

 - Commercial Solvents methylaniline plant at Terre Haute, Ind.—engineering shortcuts slice plant costs (N).....Oct. 20 *72
 - How to get more accurate plant cost estimates. N. G. Bach (charts & tables).....Sept. 22 *155
 - How to scale up pilot plant data and equipment—report. E. L. Clark (charts).....Oct. 6 *129
 - Keys to pilot plant success: equipment and safety. E. L. Clark.....July 28 119
 - Pilot plants in process technology. E. L. Clark.....Apr. 21 *155
 - Unit operations in the pilot plant. E. L. Clark.....June 2 *119

Plasticizers:

 - Fast-fusing primary plasticizer. June 20 66
 - No heat clouds from plasticizer-guarded vinyl chip.....Dec. 29 *36
 - Vinyl stearate—enough now for many markets.....Sept. 22 *93

Plastics:

 - Binder for fabrics.....July 25 76
 - Building or repair with epoxy-glass laminate. N. G. Goldstein.....Jan. 14 *142
 - Butylated plastic easy to strip. Oct. 6 144
 - Carbopol—new vinyl polymer powder plus water: instant jelly.....Oct. 20 140
 - Chemical industry will stay on top in plastics. R. P. Windisch (table).....July 14 98
 - Chicago conference—Eighth National Plastic Exposition.....Sept. 8 156
 - Design of plastic towers. P. L. McWhorter.....Apr. 7 *184
 - Epoxy paving resin features listed. Aug. 11 94
 - Films: propylene, nylon.....Sept. 22 *94
 - Fitter plates: plastic dispenses metal costs (N).....Mar. 10 92
 - Floating plastic bags to shop barging jobs (N).....Aug. 11 *158
 - Fluorocarbon plastics take on new jobs.....Aug. 11 *158
 - Foam plastics soaring.....Nov. 17 82
 - General Tire and Rubber Co.'s special school teaches plastic techniques (N).....Aug. 25 *146
 - Glass-reinforced foam.....May 5 68
 - How to select best plastic for tanks. W. Reybold.....Mar. 24 *152
 - International Plastics Standardization meeting to be held Oct. 30-31, 1958.....Oct. 6 162
 - Inventory of new processes and technology.....May 5 133
 - Isotactic polypropylene arrives here. Jan. 18 *92

Index to Vol. 64, January to December 1958

Molded urethane—the precise packing material for delicate cargo... Sept. 3	*76	Polystyrene via "natural" ethyl benzene—Coden Petroleum Co.—flow sheet..... Dec. 1	*98	Radio—Mobile two-way radio network assists in materials handling at J. T. Baker Chemical (N)..... Jan. 27	*68
Motorboats with hulls of polyethylene—brass glass for first Trans-African Waterway Expedition..... Dec. 15	32	Polyurethanes—Polyether—Sorbitol-based component for rigid polyurethane..... Nov. 3	72	Radioactivity—Radioactive gold to aid engineers in mud-migration battle (N)..... Aug. 26	68
Petrochemical series J. W. Bradley & others (tables)		Polyvinyl acetal—Bids for many jobs..... Feb. 10	*88	Radioisotopes—Radioisotopes measure mercury inventory at Australian chlorine plant (N)..... Sept. 8	*64
Pt II Ethylene..... Jan. 27	*88	Polyvinyl acetate emulsion—spray dried PVAc..... Dec. 1	76	Rayon—Rayon tire cord..... June 16	72
Pt III Propylene..... Feb. 24	88	Potassium—Fibrous potassium titanate dead-ends, 2,000°F heat..... Dec. 15	*90		
Pt IV Butylene..... Feb. 24	92	Potassium sorbate—Two new sources for food use..... Aug. 11	94	Refining:	
Phenolics beat aircraft heats... June 16	16	Powder Metallurgy—Powdered metallurgy shows off Oct. 30	184	Asarco's integrated zinc refinery delivers alloys, too—flowsheet..... Dec. 15	*128
Plastic film..... June 16	74	Powder Metallurgy Products Exhibit..... Oct. 30	184	Refiners must change their yield patterns for middle distillates and fuel oil (tables)..... Nov. 3	66
Plastic honeycomb houses pioneer instruments in satellite package... Dec. 1	*76	Recent advances..... Feb. 24	184	Shell Oil's better deasphalting keys lube-oil setup (N)..... Nov. 8	*54
Plastic molds minimize plant downtime..... Nov. 2	*150	U. K. uses no pressure in powder route to beryllium (N)..... Oct. 20	74	Spend octane dollars on today's know-how (table)..... Oct. 28	78
Plastic panel coverings handle tough plant conditions P. N. Cheremisinoff (tables)..... May 5	*152	Pressure:		U. S.-built unit gives twist to French refinery (N)..... Mar. 24	*62
Plastic protection for vessel insulation. P. N. Cheremisinoff (D. N.)... June 20	118	Assure full range flow control. Joseph Conison (charts)..... Dec. 1	*107	Refrigeration—Cutting corrosion in refrigerant drying J. A. Seiner (P.N.)..... Dec. 1	*126
Plastic tooling moves into longer runs Feb. 24	*74	Cryopumping—new technique produces high vacuum at low cost (N)..... Dec. 29	80	Refractory Materials:	
Plasticizer guarded vinyl chip—no heat clouds..... Dec. 29	*36	Estimate engineering properties W. R. Gambill, see under Engineering Heat exchanger design calculations Ning Hsing Chen, see under Heat Exchangers		Above 3,500°F what material to use? L. D. Locardi (tables)..... June 30	*105
Process plastic..... Oct. 20	82	Printed circuit—seco stitching process (N)..... Jan. 27	62	New material protects floors of marine and stationary boilers..... July 14	90
Polyesters and Teflon gain—use new markets. P. N. Cheremisinoff (table)..... May 5	*64	Proportioning—Chemical proportioning calculations J. R. Heffler..... Jan. 27	129	Refrigeration—U. S. Steel unit doubles in refrigeration and process flow (N)..... Apr. 21	*63
Polypropylene—test it under your own conditions with free welded section Nov. 17	178	Propylene:		Bell Aircraft harnesses fluorine for rocket propellant use (N)..... Oct. 8	58
Polypropylene—yarn and rope manufacturer start use..... Aug. 11	96	Houdry's dehydrogenation process opens up new avenues to propylene (N)..... Aug. 25	68	California Research Corp.'s piloting sparks isophthalic's market drive (N)..... May 17	*74
Polyvinyl acetal bids for many jobs Feb. 10	*88	New chemical markets for propylene. J. W. Bradley & others (tables)..... Feb. 24	88	Chemical spender: firms retrench and wait W. H. Chartener (tables)..... May 19	85
Power-applied organic film saves water Texas reservoir (N)..... Aug. 11	82	p-tort-butylphenol—Substitute phenol		Let's pin a dollar sign on industrial research..... Dec. 15	88
PVC compounds..... Oct. 20	84	Dec. 15		Optimum worksheets C. H. Li (charts) & tables)..... Apr. 7	151
Pyrocure—taking now available in quantity..... Jan. 16	*76	Printed circuit—seco stitching process (N)..... Jan. 27	62	Pilot plants in process technology E. L. Clark..... Apr. 21	*155
Reinforced plastic for revolvable miniature planetarium..... Apr. 21	*78	Proportioning—Chemical proportioning calculations J. R. Heffler..... Jan. 27	129	Research: the big spark W. H. Chartener (charts)..... Jan. 13	110
Rotary filter boasts plastic construction Aug. 11	*82	Propylene:		Searchers seek to open literature logjam (N)..... Feb. 10	*84
Rubber-plastic for hot-water pipe Jan. 27	76	Houdry's dehydrogenation process opens up new avenues to propylene (N)..... Aug. 25	68	Resin:	
Silica-reinforced phenolic, Astroelite vs missile-made heat..... Jan. 27	76	New chemical markets for propylene. J. W. Bradley & others (tables)..... Feb. 24	88	Astroelite—resin-silica vs. missile-made heat..... Jan. 27	*74
Transparent plastic..... Feb. 24	*74	p-tort-butylphenol—Substitute phenol		California Research Corp.'s piloting sparks isophthalic's market drive (N)..... May 17	*74
Transparent plastic models reveal answers to gas-flow problems (table) Mar. 24	*76	Dec. 15		Diepoxides..... June 16	74
Urethane foam insulates portable utility hut..... Apr. 21	*76	Inventory of new processes and technology May 5	133	Epoxy resins..... Oct. 6	58
White mineral oil will be of use to manufacturers..... June 2	60	Magnesia-base pulping breaks pollution stalemate at Brown Co. (N)..... Sept. 8	*60	Epoxy resins..... Mar. 24	*76
Wood-filled plastic..... July 28	*76	Magnesia process buttons up sulfite pulping Brown Co. newsheet (N)..... Sept. 8	*60	Open low-cost way to vacuum-forming molds..... Dec. 29	*36
Wood won't rot if coated with plastic (N)..... Mar. 10	82	No. 1 Kraft pulp process available to industry..... Dec. 29	27	"Glass-sandwich" resin can join metals Stasys Masiliukas (P.N.)..... Aug. 11	152
Plating:		Null device controls pulp consistency Massimo Rosicarsili (P.N.)..... July 14	*153	Inventory of new processes and technology May 5	133
Electro silver plating for copper bus bars Richard Minser (P. N.)..... Jan. 13	168	Vanillin—new route from pulp sulfite liquor (N)..... Jan. 18	50	Ion exchange resin..... July 28	74
Niphos Chemical process plates resin ant nickel..... Jan. 13	*172	Pulp & Paper:		Iso phthalic in pulp..... June 2	60
Polybutadiene—Shows success in tire treads (N)..... Oct. 20	74	Clips shrink process makes paper shock resistant (N)..... Mar. 10	82	Modifier for epoxies..... Aug. 25	76
Polyester film, Videne..... Apr. 7	76	Continuous digester gets better pulp faster (N)..... June 2	*58	Permaspray—protective coating June 2	63
Polyether—Sorbitol-based component for rigid polyurethane..... Nov. 3	72	Dispersing asphalt licks piping snag (N)..... May 13	70	Phenolic resin gives nitrile adhesives improved tensile strength..... Dec. 29	36
Polyethylene:		Glass paper..... July 28	74	Polyimide resin for automobile instrument panel..... Mar. 17	*24
Bakelite tries two-flank attack on low-pressure poly market (N)..... May 5	*54	Hammer mill knocks down pulping costs (N)..... July 28	62	Polyester plastic..... Oct. 20	82
Carbontilled polyethylene pipe links two plants..... Jan. 27	*152	Inventory of new processes and technology May 5	133	Polyox water-soluble resins..... Jan. 13	*94
Edmonton Alton sludge lagoons lined with polyethylene film (N)..... 21	62	Magnesia-base pulping breaks pollution stalemate at Brown Co. (N)..... Sept. 8	*60	Polyvinyl acetal bids for any jobs	
Equipment can now don polyethylene coat (table)..... Sept. 8	152	Magnesia process buttons up sulfite pulping Brown Co. newsheet (N)..... Sept. 8	*60	Feb. 10	*88
Ethylenic technology paints the market picture J. W. Bradley & others (tables)..... Jan. 27	*88	No. 1 Kraft pulp process available to industry..... Dec. 29	27	Flow resin..... Mar. 24	*78
Extrusion coating resin for paper, cellophane and foil..... July 14	90	Null device controls pulp consistency Massimo Rosicarsili (P.N.)..... July 14	*153	Steel-and-epoxy resin can cut costs of tooling..... Mar. 24	*76
Gains ease-of-use and new markets Grace, W. R. high-density polyethylene plant at Baton Rouge, La. on stream (N)..... Jan. 18	55	Vanillin—new route from pulp sulfite liquor (N)..... Jan. 18	50	Styrene-based cation exchange resin lasts longer..... May 19	*74
High-pressure polyethylene process persists—Spencer Chemical flowsheet Dec. 29	*42	Pumps:		Teflon gains ease-of-use and new markets..... May 5	*64
New films—low density: first commercial linear film..... July 14	90	Assure full range flow control. Joseph Conison (charts)..... Dec. 1	*167	Two new silicone resins—for cold-blending, for electrical insulation	
New Polyethylene resists combustion Oct. 6	*182	Corrosion-resistant putty puts new life into sea water pumps..... Aug. 11	*162	Apr. 7	74
Pneumatic conveying setup handles polyethylene at Phillips Chemical Co. (N)..... Sept. 8	90	Cryopumping—new technique produces high vacuum at low cost (N)..... Dec. 29	30	Urethanes..... Feb. 24	76
Polyethylene for outdoor use, contains an ultraviolet inhibitor..... April 1	*86	Flow resin for slurries—CE 10 file XIII Maxey Brooks..... Jan. 13	170	Water-soluble resin..... Nov. 17	84
Reactive Cr travels safely in polyethylene lined containers..... May 5	76	How to control flow of rapid-settling slurries C. W. Roos (P.N.)..... Jan. 13	*188	Rockets and missiles—report R. L. Noland (tables)..... May 19	*145-160
Rigid polyethylene..... Nov. 4	*70	How to solve soft packing problems Walter Cooley..... Jan. 27	*131	Rocket-propellant process—Astrodyne Inc. solid-propellant plant—flowsheet	
Slush molding slated (N)..... June 16	52	Microwave controls supply of plant water at Olin Matheson Chemical's East Alton, Ill. plant (N)..... Apr. 7	*63	Apr. 21	*126
Stiffer polyethylene finds commercial niches..... June 2	*60	Operation and maintenance—Chemical process pumps R. R. Rhodes		Rocket propellants—Bell Aircraft harnesses fluorine for rocket propellant use (N)..... Oct. 6	58
Thioether guard polyethylene against thermal oxidation..... Mar. 10	90	Right material cuts pump costs F. R. Drabos..... Mar. 10	*162	Butyl rubber..... Sept. 22	*92
Two polyethylenes—low-melt and medium-density variety..... Feb. 10	90	Vertical pumps Cannon & Lundquist Mar. 10	*139	Butylene? Watch rubber J. W. Bradley & others (tables)..... Feb. 24	92
Whale trapping to allow polyethylene? (charts & table).... Sept. 22	96	Radiation:		Continuous rubber route does a new look—flowsheet..... June 2	*102
Polymerization—"Transient" catalyst streamlines silicone polymerization (N)..... Nov. 3	64	Co-60 opens new route to low-cost detergents (N)..... Nov. 3	56	Continuous vulcanized curves extrusion fast (N)..... May 5	*60
Polystyrene:		How to design for radiant heating L. M. Polentz (charts & tables)..... I, Apr. 7-18, II, Apr. 31	161	Fluorinated rubber Viton, resists heat pipe fluids..... Apr. 31	*72
Polystyrene film..... June 20	*64	Lead slag gives low-cost shield (N)..... Jan. 27	60	Goodyear Tire & Rubber's expanded plant uses continuous route (N)..... Jan. 27	60

NOTES—(D.N.) Design Notebook; *Illustrated; (N) News; (P.N.) Plant Notebook

Inventory of new processes and technology	May 5	123	
Nitrile rubber	Feb. 24	76	
Nitrile silicone rubber	Sept. 22	84	
Polybutadiene rubber	Aug. 25	74	
Polybutadiene shows success in tire tests (N)	Oct. 26	74	
Silicone rubber	June 20	64	
Trends in rubber chemicals, France (Arns (tables))	June 16	84	
Two new forms—deutero rubber and liquid rubber	June 20	64	
U. S. Rubber know-how sprouts in Germany — Bunawerke Huel's new plant (N)	Nov. 17	*68	
Vulcanizing process stretches life span (N)	July 14	92	
Rubidium and cesium chemicals	Feb. 10	92	
Rupture disks—Procedures on installations J. E. Bigham	April 7	*143	
Russia:			
Chemical expansion emphasized (N)	Oct. 6	58	
Five-year planners eye Russian fuels (N)	Sept. 22	78	
Russian chemicals: strength, weakness	Aug. 25	70	
S			
Safety			
Airplane overheating-detector goes industrial	Apr. 21	*78	
Calculate adequate rupture disk size	J. G. Lowenstein	Jan. 13	157
Color-coding for tankcars	Sept. 22	182	
Dry ice lumps decrease fire hazard	Barnes & Huber (P.N.)	July 14	*154
Keys to pilot plant success: equipment and safety	E. L. Clark	July 28	119
Montane safeguards new insecticides plane with cordon of safety features (N)	Mar. 10	*76	
Organise for safety	Jack Bedford (chart)	Sept. 22	180
Robot operator for fire door	P. C. Ziemke (P.N.)	Aug. 11	*153
Union Carbide Texas City oxygen plant explosion—clues gathered (N)	June 16	82	
Salesmen—Salaries up	Aug. 11	156	
Salvage—Salvage operation saves 1,000 oil nozzles	Sept. 22	*186	
Sampling			
Collect samples proportional to varying flow	Stepnowski & Smith (P.N.)	July 14	*152
Collecting integrated gaseous samples	Brief & Drinker (D.N.)	Nov. 17	*162
Phase separator used for preferential sampling	Klims & Byon (P.N.)	Mar. 24	*148
Sampler for particles in water gas streams	J. W. Thomas (P.N.)	Feb. 10	*148
Screening—Kill static in lab screening	Morton Allen (D.N.)	Sept. 22	*176
Sealing			
Acid resisting cements cure sealing problems	P. C. Ziemke (P.N.)	Jan. 13	168
New resistant gaskets end sealing problems	B. G. Staples	Oct. 20	*180
Seals—Ordering mechanical seals	Harold Barts	Sept. 22	*178
Separation			
Centrifugation can select solids by density	Merton Allen (D.N.) (chart)	Dec. 15	*182
Columbium and tantalum—flowsheet	Electro Metallurgical Co. extraction Nov. 3	*104	
Cyclone winnows asbestos fibers from dust (N)	Dec. 15	*82	
Glass sink trap becomes reflux separator	R. A. Snedeker (D.N.)	May 5	*150
Methyl borate	Dec. 29	36	
Molecular sieves—sharp, selective adsorption pays off (N)	Oct. 20	*186	
Phase separator used for preferential sampling	Klims & Byon (P.N.)	Mar. 24	*148
Polystyrene via "natural" ethyl benzene—Corden Petroleum Co.—flowsheet	Dec. 1	*98	
Silver fluoroborate scrubbing solution separates olefins (N)	Sept. 22	82	
Splitting by permeation boasts commercial worth (N)	June 2	80	
Wah Chang's silicon production flowsheet	Jan. 13	*128	
Shale Oil			
Newest advances brighten hopes for oil from shale (N)	Sept. 8	70	
Oil shale, tar sands promise economic fuels (N)	Nov. 3	58	
Shipping			
Bus carriers with built-in pneumatic handling systems	Feb. 10	*94	
Floating plastic bags to chop barging costs (N)	Mar. 10	82	
Tankcars cut shipping costs for cryostats (N)	Feb. 10	*80	
Silane—German process is safer, cheaper (N)	Dec. 15	76	

Silica			
Formed silica: hard-to-beat properties (table)	Aug. 25	142	
Resin-silicite	Astroline, vs. missile-made heat	Jan. 27	*74
Silicon			
Silicon market: shrinking as it grows (charts and tables)	Mar. 10	102	
Westinghouse's new pilot unit turns out ultrapure silicon (N)	June 16	70	
Silicones			
British makes silane fractions for silicones (N)	Mar. 24	*62	
Silicone intermediate	Jan. 27	76	
"Tremont" catalyst streamlines silicone polymerization (N)	Nov. 3	84	
Two new fluids, two new resins	Apr. 7	74	
Use broadened via reactive epoxy terminals	Mar. 10	92	
Silver fluoroborate scrubbing solution separates olefins (N)	Sept. 23	82	
Sodium			
Bulk station shows-off easy sodium handling at Mallory-Sharon Metals (N)	June 22	*63	
Continuous analyser determines sodium content in sodium-lead alloy	Aug. 11	82	
Eddy current brake bridges sodium flow (N)	May 19	*66	
Sodium-reduction route yields titanium flowsheet	Mar. 10	*124	
Sodium sulfate—Crystallization: key step in sodium sulfate process—flowsheet	Aug. 11	*116	
Solar Power			
Amy's new solar furnace uses patchwork mirror (N)	Oct. 20	72	
Sun-heated home (N)	Apr. 21	68	
Solids			
Formulas for suspension and solids—CE flow file XIV	Maxey Brooke Jan. 27	140	
One slide-rule setting finds solids dilution	Merton Allen (P.N.)	Apr. 21	168
Solutions—Nomograph gives settling velocity	M. Rhoden (P.N.)	Mar. 10	160
Solvents			
Perchloroethylene — new HC1 chili highlights new perchlor process—flowsheet	May 5	*116	
Solvent blues: it's not just the recession	Aug. 11	90	
Standardization			
How to start a standards program	Brand & Sister	Feb. 19	141
International Plastics Standardization meeting to be held Oct. 30-31, 1958	Oct. 6	162	
Starch			
Etherized starch finish for textiles	Aug. 11	*86	
Fractionation process from Netherlands beats plant genetics in race to produce amylose (N)	Mar. 24	*86	
Steam			
Automatic coal-fired packaged generator yields ready steam	June 2	*66	
Electrolytic cause of steam system trouble	J. F. Kuong (D.N.)	Aug. 25	*131
How to allocate process steam costs	Katell & Joyce (charts)	Mar. 10	152
Nomograph gives steam condensed by air	Y. P. Varshni (D.N.)	June 2	130
Selecting ejectors for high vacuum	C. G. Limck (charts)	Jan. 18	*145
Sight glass checks on exhaust steam quality	Richard Minser (P.N.)	Apr. 31	*168
Simple way to measure steam quality	Robert Lemlich (D.N.)	Apr. 7	*162
Steam trace for glass pipe	Scace & Fried (P.N.)	Aug. 11	*152
Steel			
Automatic lead cladding slasher costs	June 20	*122	
Basic oxygen steel process lists another gain (N)	Feb. 10	78	
Colored stainless	May 5	66	
Easy test spots different stainless types	Nov. 17	*174	
Infrared lamps stop steel corrosion (N)	Aug. 25	146	
Low-cost cryogenic steel goes commercial	J. Procter (charts)	July 14	*141
Magnetic staves	Jan. 18	*94	
New alloy steels beat process bugs—Roach & Hall (tables)	I—May 19 180, II—June 2	124	
New coating turns mild steel into stainless	Nov. 17	178	
Stainless D119 better than type 316 (table)	Dec. 15	194	
Stainless steel screens keep well from running dry	Oct. 20	*184	
Steel industry exploits hydrogen-top technical trend of the year	Jan. 13	139	
Tips on maintaining stainless steel ware	P. C. Ziemke (P.N.)	Nov. 3	146
Ultra-high strength steel available	Oct. 6	164	
What you can do to reduce stress corrosion	F. J. Poss	July 28	140
Styrene—Ethylene: technology paints the market picture	J. W. Bradley & others (tables)	Jan. 27	*92

Sugar—Industrial Sugars, Inc.	modern touch speeds up decolorizing (N)	Mar. 10	*80
Sulfur			
Canadian pipeline plan could increase yearly output of sulfur from gas-stripping operations	Dec. 15	86	
Freepoint Sulfur's mine on stilts will win Frasch sulfur (N)	July 28	60	
French plant to make sulfur from sour gas (N)	May 19	*72	
Inco nickel process pioneers sulfur distillation (N)	Apr. 7	*61	
Packaged unit wrings sulfur from gas (N)	May 19	*73	
Sulfur takes over at Spindletop—Texas Gulf Sulfur installation—flowsheet	Nov. 17	*126	
T			

Toxins			
CE Cost File II Cost of process vessels	Harold Gushin (charts)	July 14	158
Current costs of vessels and motor reducers	CE Cost File—IV	Harold Gushin	Sept. 1
Fluid mixing in tankcars	R. L. Bates	Aug. 25	*136
How to select best plastic for tanks	W. Reybold	Mar. 24	*152
Simplified siphon also holds its prime	C. F. A. Roberts (P.N.)	Dec. 29	*66
Solve batch liquid metering problems with a volumetric tank	Max Bass	Oct. 20	*150
Tank siphon never loses prime	C. F. A. Roberts (P.N.)	Oct. 5	*153
Vent breather protects solvent storage tanks	C. W. Hamilton (D.N.)	Oct. 20	*169
Tantalum			
Columbium and tantalum—flowsheet	Electro Metallurgical Co. extraction	Nov. 2	*104
Output rising, price cut in view? (N)	Sept. 8	64	
Taxes—Graduate study gets tax rebate	Oct. 20	172	
Technology			
Ethylene: technology paints the market picture	J. W. Bradley & others	Jan. 27	*788
Inventory of new processes and technology		May 6	125-128
Temperature			
About 2,500 F. what material to use?	L. D. Koch (table)	June 20	*105
Barium Reduction Co.'s lower process temperature ups BaO quality (N)	Oct. 6	*56	
Estimate engineering properties	W. R. Gambill see under Engineering	Jan. 17	*64
Film tells flame temperature (N)	Brown-report (charts & table)	Apr. 21	*135-150
High temperature catalytic process boosts HCN yields (N)	Aug. 26	61	
High-temperature metals	E. N. Skinner Jr.	Dec. 15	137
High-temperature nonmetals	R. W. Brown-report (charts & table)	Apr. 21	*135-150
Intense arc pierces temperature barrier (N)	Dec. 29	*24	
Quicker temperature conversions—comment from readers (P.N.)	May 19	176	
Textiles			
Etherized starch finish	Aug. 11	*96	
Textile softeners	Aug. 11	94	
Thermodynamics			
Heat capacity ratios—5 hydrocarbons	Joffe & Delaney (graphs)	Mar. 24	128
Heat content and vapor pressure of hydrogen peroxide	Simkin & Hurd (charts & tables)	Jan. 13	155
Heat exchanger design calculations	Ning Hsing Chen see under Heat Exchangers	July 14	147
High-temperature nonmetals	R. W. Brown-report (charts & table)	Apr. 21	*135-150
How to set up the necessary mathematics	Ball & Johnson	Jan. 27	135
Pit differential equation to standard form	Jan. 27	135	
Solve second-order linear equations	Feb. 24	145	
Mass transfer operations	J. O. Osburn	Mar. 24	145
Mechanics of mass transfer	Apr. 21	*161	
How to use mass transfer coefficients	May 19	169	
How to modify mass transfer equations	June 16	183	
Find number of theoretical stages	July 14	147	
Transfer unit simplifies calculations	July 14	147	
Mass transfer behavior in fixed beds	Sept. 8	147	
Correlate mass transfer coefficients	Ang. 11	147	
Estimate efficiency in mass transfer	Oct. 6	146	
	Dec. 1	119	

Thermal data for chlorine and HCl. C. J. Dobratz (charts & tables)	Feb. 10	144
Thickeners—Operation and maintenance —Thickeners and clarifiers. G. O. Wilson	June 16	*168
Thioethers—Guard polyethylene against thermal oxidation	Mar. 16	90
Thorium—Flexible process tactics capture nuclear products at Davison Chemical's Erwin, Tenn. plant (N).	Apr. 21	62
Tires Rayon tire cord	June 16	72
Tire-cure process promises more mileage (N)	June 2	50
Titanium Easy-to-work titanium alloys. Aug. 11	162	
High-temperature alloy developed	Dec. 15	198
King-sized titanium plate produced for chemicals	Feb. 24	*160
More rutile coming from domestic mines (N)	Jan. 13	86
New route to rutile from ilmenite studied in Australia (N)	Dec. 1	60
Sodium-reduction route yields titanium —flowsheet	Mar. 10	*124
Titanium-alloys stronger, more resistant	Nov. 2	152
Titanium dioxide process taps socal slag for savings—flowsheet. Jan. 27	*98	
Titanium Metals Corp. new plant	Feb. 10	152
Welding not difficult	June 16	198
Training General Tire and Rubber Co.'s special school teaches plastic techniques (N)	Aug. 25	*146
Train your own instrument men. Big ham & Kuntze	Nov. 17	*168
Tri-n-butyl phosphine	Nov. 3	70
Trimethoxyborazine—Liquid used in fire extinguishers	Sept. 3	78
Trucks—Bulk carriers with built-in pneumatic handling systems. Feb. 10	*94	
Tubing—Tin-lined copper tubing. Feb. 10	158	
Tungsten carbide—Spray on coating	June 30	*126
Turbines Gas turbines up process efficiency. J. E. Parker	July 28	*123
Water models used to design turbines (N)	Dec. 29	*27
U		
Ultrasonics Agitator finds many new applications	Mar. 10	*94
Big advances in ultrasonic welding	Mar. 10	166
Unit Operations For mass transfer—quick method finds optimum trays and reflux ratio. John Happel	July 14	144
How to scale up pilot plant data and equipment — report. E. L. Clark (charts)	Oct. 6	*129-140
Mass transfer operations see series under "Chemical Engineering Re- fresher"		
Pilot plants in process technology. E. L. Clark	Apr. 21	*155
Unit operations in the pilot plant E. L. Clark	June 2	*119
Uranium Centrifugal extraction makes uranium debut (N)	June 30	60
Electrolytic extraction process goes into pilot-plant stage (N)	Jan. 27	70
Flexible process tactics capture nuclear products at Davison Chemical's Erwin, Tenn. plant (N)	Apr. 21	62
Irvington-Baker Refining Div. of En- gelhard Industries wrings profit from cold strap (N)	Oct. 6	*50
W		
Waste Disposal Atomic waste hazard cut by fluid-bed calcining (N)	Nov. 17	76
Brown Co.'s magnesia-base pulping breaks pollution stalemate (N)	Sept. 8	*60
How to cope with a water pollution problem—report	July 14	*129-140
Irvington-Baker Refining Div. of En- gelhard Industries wrings profit from cold uranium scrap (N)	Oct. 6	*50
Magnesia process buttons up sulfite pulping—Brown Co. flowsheet	Sept. 8	*114
New waste disposal process—wet oxida- tion. F. J. Zimmerman (charts & table)	Aug. 25	*117
Ohio Standard's giant waste CO boiler saves heat, cuts fumes (N)	May 5	58
Ozone counters waste cyanide's lethal punch at Boeing Airplane's Wichita, Kan. plant (N)	Mar. 24	*62
X		
Xylenes—Chlorinated xylenes	Oct. 6	68
Z		
Zinc Asarco's integrated zinc refinery deliv- ers alloys, too—flowsheet	Dec. 15	*128
New zinc-base alloy gives longer die life	Mar. 10	90
Zinc in foil form is pilot-scale reality (N)	June 16	62
Zinc oxide—Flash oxidation slashes me- tallic oxide costs (N)	Dec. 15	*78
Zirconium Crystallization wins hafnium-free cir- conium for Russians (N)	Mar. 10	86
Giant zirconium ingots to yield low- cost mill products	Nov. 3	*154
How zirconium fabricating difficulties were solved	Oct. 6	*164
More popular than ever for nuclear reactors	Nov. 17	174
Reactive Zr travels safely in polyethy- lene lined containers	May 5	*66
Zirconium now sweeps into the big time—flowsheet	Jan. 18	*128
Zirconium outlasts stainless in chlorine service	June 16	*198

AUTHOR INDEX

Adams, J. F. & others Computer speeds economic evaluations	June 30	99
Allen, F. H. & W. M. Robinson Flange-inserted thermowell easy to in- stall	Dec. 1	*125
Allen, Merton Centrifugation can select solids by density	Dec. 15	*182
Kill static in lab screening	Sept. 22	*176
One slide rule setting finds solids dilu- tion	Apr. 21	162
Archer, W. E. Troubleshooting dust collectors	Dec. 15	*188
Arns, Frances Manufactured gas	Mar. 24	*121
Trends in rubber chemicals	June 16	84
Babcock, Lyndon Balloons pace gas velocity	Mar. 24	*148
Bach, Norman G. How to get more accurate plant cost estimates	Sept. 22	*155
Bacon, John B. Petroleum feels the pinch	Mar. 24	88
Ball, William E. & R. Curtis Johnson How to set up the necessary mathe- matics		
Fit differential equation to standard form	Jan. 27	135
Solve second-order linear equations	Feb. 24	145
Barnard, R. D. Operation and maintenance—Technical service groups	June 16	*144
Barneby, H. L. & W. L. Lewis Costs of solvent recovery systems	Dec. 29	*51
Barnes, E. J. & W. J. Huber Dry ice lumps decrease fire hazard	July 14	*154
Bartz, Harold Ordering mechanical seals	Sept. 22	*178
Bass, E. L. & N. P. Green Checkup on cooling tower operation	Dec. 1	*111
Bass, Max Solve batch liquid metering problems with a volumetric tank	Oct. 20	*150
Bates, Robert L. Fluid mixing in tankcars	Aug. 25	*136
Battista, O. A. Six sure steps to the top	Feb. 24	*185
Bedford, Jack Organise for safety	Sept. 22	180
Benenati, Robert F. Inside insulation saves cost	May 5	*148
Berg, Robert H. Handy way to scale drawings for flow sheets	May 19	174
Bierbower, R. G. Simple flowmeter handles small liquid flows	Feb. 10	*152
Bigham, J. E. Calculate spring-loaded relief valves	Feb. 10	*188
Procedures on rupture disk installation	Apr. 7	*142

NOTES—(D.N.) Design Notebook; *Illustrated; (N) News; (P.N.) Plant Notebook

Index to Vol. 64, January to December 1958

XV

- Bigham, J. E. & J. A. Kuntze
Train your own instrument men Nov. 17 *168
- Bley, R. E.
Optimize your maintenance stores Oct. 20 174
- Bodurtha, F. T. Jr.
Flare stacks—How tall?... Dec. 15 *177
- Borsvold, Herbert
Percent-time predicts process end Jan. 18 166
- Bradley, James W. & others
Petrochemical series
Pt II—Ethylene Jan. 27 *88
Pt III—Propylene Feb. 27 *88
Pt IV—Butylene Feb. 24 92
- Brady, S. O.
Pollution control report — Stardust management has decided its course July 14 *140
- Brand, D. C. & C. W. Sisler
How to start a standards program Feb. 19 141
- Brief, R. S. & P. A. Drinker
Collecting integrated gaseous samples Nov. 17 *162
- Brooke, Maxey
CE flow file
Pt XIII Jan. 13 170
Pt XIV Jan. 27 140
- Brown, Roy W.
High-temperature nonmetallics Apr. 21 *185
- Buell, C. R. & L. W. Pollock
Stimulant to creative engineering Oct. 20 *147
- Bullock, H. Leslie
Inverted bottle makes a constant-head feeder Oct. 20 *176
- Water-still controls itself automatically Dec. 29 *65
- Campbell, Keith & J. M. Crocker
Avoid trouble in using your Parshall flume Nov. 8 *145
- Cannon, James P. & J. A. Lundquist
Vertical pumps Mar. 10 *189
- Carbone, D. J. & A. W. Francis
Calculate height of a fluidized bed Mar. 10 158
- Carroll, Joe R.
Pollution control report — the state must act on stream pollution July 14 *132
- Charlton, J. B.
Plant operations are easier to visualize when you use a yield and capacity chart Mar. 24 142
- Chartener, William H.
Chemical profits: harder to keep a buck Apr. 7 86
- Chemical spending: firms retrench and wait May 19 86
- Plant building takes a breather Jan. 13 106
- Research §§: the big spark. Jan. 18 110
- Will sagging chemical outlays perk up Soon? Dec. 15 84
- Chen, Ning Hsing
New, fast accurate method to find tubeside heat transfer coefficient June 30 110
- Save time in heat exchanger design Oct. 29 153
- Shellside heat transfer coefficient Dec. 1 117
- Speed heat exchanger computations Oct. 6 149
- Speed pressure drop calculations Sept. 22 160
- Tubeside heat transfer coefficient Nov. 17 155
- Cheremisinoff, P. N.
Plastic panel coverings: handle tough plant conditions May 5 *152
- Plastic protection for vessel insulation June 30 118
- Cheremisinoff, P. N. & R. P. Durkin
Illuminated device inspects translucent materials Aug. 11 *153
- Chilton, Cecil H.
Metal supplies: more than enough at last June 30 *78
- Clark, E. L.
Equipment and safety: keys to pilot plant success July 28 119
- How to scale up pilot plant data and equipment Oct. 6 *129
- Pilot plants in process technology Apr. 21 *155
- Unit operations in the pilot plant June 2 *119
- Coffer, L. W.
Atomic-age metal extraction. Jan. 27 *107
- Conison, Joseph
Assure full range flow control. Dec. 1 *107
- Cooper, Walter
How to solve soft packing problems Jan. 27 *181
- Coderre, R. A. & T. G. Nock
Build or repair with epoxy-glass laminates Jan. 27 *148
- Cortelyou, Ethaline
Today, accuracy demands the first person Nov. 2 *147
- Crocker, J. M. & Keith Campbell
Avoid trouble in using your Parshall flume Nov. 8 *145
- Cronan, C. S.
Uranium industry needs a new incentive June 2 72
- Cushing, R.
Special coatings will resist spillage Feb. 24 156
- Crooks, Robert G.
Review patent fundamentals. Feb. 24 *121
- Cryden, Joseph
Engineers go back to high school Nov. 17 *163
- Davis, D. S.
Reliability of simple approximation Feb. 10 150
- Davis, W. L. & H. L. Barneby
Costs of solvent recovery systems Dec. 29 *51
- De Lanauer, H. J.
Cost of U-tube heat exchangers. Oct. 6 141
- Finned tube floating head exchangers, 150 psi Nov. 17 166
- Fixed tube sheet exchangers and kettle reboilers Dec. 15 181
- Floating head and fixed tube sheet heat exchangers Dec. 29 63
- Delaney, E. G. & Joseph Joffe
Heat capacity ratios—6 hydrocarbons Mar. 24 138
- De Lorenzo, J. F.
Lining techniques halves vessel cost Dec. 29 *70
- Derrick, George C.
Reduce your maintenance costs July 28 182
- Dershowitz, A. F. & H. R. McEntee
Joint products and byproducts Dec. 29 61
- Dillon, C. P.
How much life in graphite heat exchangers? Sept. 22 *184
- Dixon, Thomas J.
Air-excluding constant feeder. Jan. 27 *142
- Dmytryseyn, M. & others
Computer speeds economic evaluations June 30 98
- Dobratz, C. J.
Thermal data for chlorine and HCl Feb. 10 144
- Drahos, F. R.
Right material cuts pump corrosion Mar. 10 *162
- Dressel, Oliver D.
Build a dust- and water-tight unloader June 16 *189
- Drinker, P. A. & R. S. Brief
Collecting integrated gaseous samples Nov. 17 *162
- Drotor, J. M. & J. P. Tassoney
Speed trial and error solution for pipe diameter Sept. 8 188
- Duncan, D. L.
Nylon 6 for process applications Dec. 1 *130
- Durkin, R. P. & P. N. Cheremisinoff
Illuminated device inspects translucent materials Aug. 11 *153
- Dutton, H. W. Jr. & others
Improve agitator performance. June 16 *172
- Eatman, P. W.
Metal fatigue can sabotage your success June 16 191
- Eickmeyer, A. G.
Costs favor hot carbonate process Aug. 26 113
- Erwood, E. J. & C. A.
Adjustable platform aids material loading Mar. 10 *153
- Fair, C. M.
Meter without orifice handles small flows Oct. 6 *154
- Finlayson, Kenneth
Rate economic factors by importance Jan. 18 151
- Fischer, John
Practical pneumatic conveyor design June 2 *114
- Fischer, William H.
Dew point gives moisture content of gases May 19 178
- Old trick averts error in figuring dilution Sept. 8 149
- Flodin, C. R. & R. F. O'Mara
Considerations for controlling dust and fumes May 5 *139
- Francis, A. W. & D. J. Carbone
Calculate height of a fluidized bed Mar. 10 158
- Franks, Foster
Drilling rubber-lined pipe under vacuum Feb. 24 *152
- Freeman, Robert R.
How chemical engineers serve Uncle Sam May 5 *161
- Fried, A. J. & J. R. Seace
Steam trace for glass pipe. Aug. 11 *152
- Gambill, Wallace R.
Estimate engineering properties
Latent heat II—Temperature vs. heat of vaporization. Jan. 13 159
III—Predict mixture heat of vaporization Feb. 10 137
- IV—Find heat of fusion and sublimation Mar. 10 147
- Surface tension for pure liquids Apr. 7 146
- Surface and interfacial tension May 5 143
- Predict diffusion coefficient June 2 125
- Predict liquid diffusivities June 20 118
- Best methods for Prandtl number Aug. 25 121
- Estimate low-pressure gas viscosity Sept. 23 169
- How T and P change gas viscosity Oct. 20 157
- To get viscosity for a gas mixture Nov. 17 157
- Garrett, D. E. & G. P. Rosenbaum
For your next purification problem: crystallization Aug. 11 *125
- Gibbons, Edward J.
Chart selects centrifugal fans. Jan. 27 144
- Chart visualizes heat transfer relations June 2 129
- Githens, R. E. Jr.
Let computers pick your exchangers Mar. 10 *143
- Goldberg, Melvin
Pesticides figure on boost from Soil Bank Feb. 10 *102
- Green, N. P. & H. L. Bass
Checkup on cooling tower operation Dec. 1 *111
- Gulley, R. P.
Pollution control report—refinery can meet goal with new investment July 14 *155
- Gushin, Harold
CE Cost File
- I June 16 187
- II July 14 158
- IV Sept. 8 141
- Hall, A. M. & D. B. Roach
New alloy steels beat process bugsaboos
- II May 19 186
- June 2 134
- Hamilton, C. W.
Vent breather protects solvent storage tanks Oct. 20 *169
- Hammond, G. P. & R. C. Kinstler
Let photography speed your drafting May 19 *161
- Happel, John
Easy way to optimum exchangers Sept. 8 135
- For mass transfer—quick method finds optimum trays and reflux ratio July 14 144
- Head, G. L.
"Quickie" substitute for a venturi meter Dec. 1 *126
- Heffer, John R.
Chemical proportioning calculations Jan. 27 129
- Hobbs, Norman L.
Electronic oven defrosts enzymatic material Dec. 29 *66
- Holzman, J. M.
New optical methods spot hidden corrosion April 21 *170
- Horvath, P. J. & R. F. Schubert
Find distillation stages graphically Feb. 19 139
- Howe, H. N. & T. O. Menary
Materials handling equipment. June 18 164
- Huber, W. J. & E. J. Barnes
Dry ice lumps decrease fire hazard July 14 *154
- Hurd, C. O. & D. J. Simkin
Heat content and V. of H_2O . Jan. 12 153
- Imzande, Robert R.
Consider buying used equipment July 14 *141
- James, Robert L. & others
Petrochemical series
Pt II—Ethylene Jan. 27 *88
- Pt III—Propylene Feb. 27 *88
- Pt IV—Butylene Feb. 24 92
- Jelen, F. C.
Major-cost analysis methods yield equivalent answers July 23 116
- Remember all three in cost analyses Jan. 27 *123
- Jelinek, Robert V.
Corrosion—refresher on cause and cure Pt I July 28 114
- Design factors in corrosion control Nov. 17 *151
- How environment directs corrosion control Sept. 22 158
- How oxidative corrosion occurs Aug. 26 *125
- Protective coatings limit corrosion Oct. 20 163
- Jenney, T. M.
Charts give you percent conversion in each reactor stage May 19 166
- Joffe, Joseph & E. C. Delaney
Heat capacity ratios—6 hydrocarbons Mar. 24 138
- Johnson, R. Curtis & William E. Ball
How to set up U.S. necessary mathematics
- Fit differential equation to standard form Jan. 27 135
- Solve second-order linear equations Feb. 24 145
- Johnson, R. L.
Find gas velocity by ammonia injection Dec. 1 126
- Joyce, T. J. & S. Katell
How to allocate process steam costs Mar. 10 152
- Katell, S. & T. J. Joyce
How to allocate process steam costs Mar. 10 152
- Katz, Dr. Raphael
Chemical engineers continue to lose ground Mar. 24 161

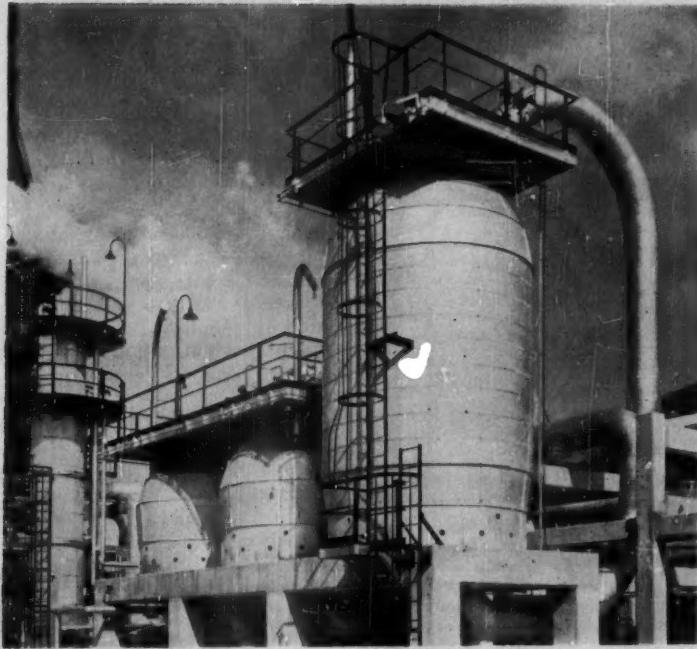
NOTES—(D.N.) Design Notebook; *Illustrated; (N) News; (P.N.) Plant Notebook

- Rise of contract maintenance June 16 *146
 Killian, J. R. Jr.
 What's wrong with engineering education..... Apr 7 173
 King, John A.
 Cue for atom-fuel processing..... Oct. 6 *62
 Kinstler, R. C. & G. P. Hammond
 Let photography speed your drafting..... May 19 *161
 Klapper, William T.
 Versatile reflux system..... June 2 *180
 Klima, B. B. & A. D. Ryon
 Phase separator used for preferential sampling..... Mar 24 *148
 Knapp, H. G.
 Trick for a water line repair..... May 19 176
 Knighten, Walter L.
 How to run an effective meeting..... Jan 27 *157
 Kunte, M. V. & M. U. Pai
 Quick calibration for small gas flow-meters..... Apr 7 *160
 Kuntze, J. A. & J. E. Bigham
 Train your own instrument men..... Nov 17 *168
 Kuong, Javier F.
 Educator cuts noise of live steam heating..... Aug 25 *131
 Gas replace manometer in an emergency..... Aug 11 *154
 Weighted thermocouple helps installation..... July 14 *154
 Lammers, Gerard C.
 Equations give time-value of § July 28 126
 Lavergne, B. A. & Benjamin C. Y. Liu
 Graph for Van Laar constants Aug 25 132
 Lee, Chesman A.
 Easy way to fabricate elbows July 28 *123
 Easy-build butterfly valve..... Mar 10 *156
 Leedom, R. P. & others
 Improve agitator performance June 16 *172
 Lemlich, Robert
 Simple way to measure steam quality..... Apr 7 *162
 Lessells, Gerald A.
 How to make and use more effective graphs..... July 28, Aug. 11 109-141
 Material balance shows homogeneous flow..... Apr 7 *160
 Li, C. H.
 Worksheet gives optimum conditions..... Apr 7 151
 Linck, C. G.
 Selecting ejectors for high vacuum..... Jan 13 *145
 Lindamood, D. M.
 Convenient flow formulas for water in pipes..... Feb 10 152
 Liss, Bernard
 Calculate fractional powers by chart..... June 30 118
 Loch, Luther D.
 Above 2,500 F., what material to use?..... June 30 *105
 Lorraine, L. E.
 Simple statistics beats blend problem..... Apr 7 *166
 Lowenstein, J. G.
 Calculate adequate rupture disk size..... Jan 13 157
 Nomograph for turbulence mixers..... Apr 7 141
 Lu, Benjamin C. Y. & B. A. Lavergne
 Graph for Van Laar constants Aug 25 132
 Lundquist, J. A. & James P. Cannon
 Technical brief..... Mar 10 *159
 MacGregor, Douglas
 Handling volatile liquids..... Mar 10 *158
 MacLeod, I. & others
 Improve agitator performance June 16 *172
 Manly, C. G.
 Nuclear power future..... Mar 10 *133
 Mason, Joseph G.
 Brainstorming..... July 4 155
 Massey, W. L. Jr. & others
 Computer speeds economic evaluations..... June 30 .99
 Maziliuskaa, Stazy
 "Glaze-sandwich" resin..... Aug 11 152
 McClaine, Leslie A. & Elliot Schrier
 Team effort diagnoses obsolescence..... Nov 3 128
 McCormick, P. V.
 Operations define dryer design..... June 16 *154
 McEntee, H. R. & A. F. Dershowitz
 Joint product coating..... Dec. 29 81
 McLane, L. E.
 "Internal seal pots" eliminate gage plugging..... June 30 *117
 McWhorter, P. L.
 Design of plastic towers..... Apr 7 *164
 Menary, T. O. & H. N. Howe
 Materials handling equipment June 16 164
 Messing, Richard H. & others
 Petrochemical series..... Jan 27 *88, Feb 24 88-92
 Mills, K. E.
 Pollution control report—moderator introduces the problem..... July 14 *130
 Miner, Richard
 Easy silver plating for copper bus bars..... Jan 13 168
 Sight glass checks on exhaust steam quality..... Apr 21 *168
 Mitchell, W. W.
 Use salt water cooling towers June 16 *181
 Moore, Robert W.
 Pneumatic conveyor cools hydrated crystals..... Nov 3 *146
 Morris, P. J. & others
 Improve agitator performance June 16 *172
 Murray, C. L.
 Use specific gravity like molarity Oct 6 155
 Nachod, J. Ernest
 How leasing conserves capital June 16 150
 Nock, T. G. & R. A. Codore
 Build or repair with epoxy-glass laminates..... Jan 27 *148
 Obrochta, R. J.
 Get a job from the man who owns one: never..... Dec. 15 *184
 Olson, Robert S.
 Use graph to design for optimum economic extraction..... Oct 6 141
 O'Mara, R. F. & C. R. Flodin
 Considerations for controlling dust and fumes..... May 5 *129
 Osburn, James O.
 CE Refresher Mass transfer operations..... Mar 24 *145; April 21 *161; May 19 169; June 16 183; July 14 146; Aug 11 147; Sept 8 142; Oct 6 146; Dec. 1 119
 Pacifico, Carl
 How "Dear Boss" letters spawn creativity..... Jan 13 *151
 Pai, M. U. & M. V. Kunte
 Quick calibration for small gas flow-meters..... Apr 7 *160
 Parker, J. E.
 Gas turbines up process efficiency..... July 23 *123
 Paul, J. K.
 Jacketing insulated equipment Aug 11 *154
 Paxton, Robert & Stanley Seltzer
 Home washer doubles as pilot extractor..... Apr 7 *155
 Pettyjohn, A. R.
 Pollution control report..... July 14 *133
 Pirie, E. C.
 Wallet-size slide rule..... Sept 22 *175
 Polentz, L. M.
 How to design for radiant heating..... I April 7 137; II..... April 21 151
 Save with direct-fired gas..... Sept 8 150
 Pollock, L. W. & C. K. Buell
 Stimulant to creative engineering..... Oct 26 *147
 Poss, Fred J.
 What you can do to reduce stress corrosion..... July 28 140
 Procter, J.
 Low-cost cryogenic steel goes commercial..... July 14 160
 Ramey, H. J. Jr.
 Read time direct in decimal units..... Aug 25 *131
 Reed, Glen G.
 Continuous and batch filters June 16 *160
 Reid, Cecil
 Pollution control report..... July 14 *131
 Resnick, William
 Rule-of-thumb finds pipe size..... July 14 154
 Reybold, W.
 How to select best plastic for tanks..... Mar 24 *152
 Reys, John
 Cost of graphite equipment..... Feb 24 *137
 Rhoden, M.
 Solving velocity nomograph..... Mar 10 160
 Rhodes, Fred H.
 What's wrong with engineering education..... Apr 7 173
 Rhodes, R. R.
 Chemical process pumps..... June 16 178
 Roach, D. B. & A. M. Hall
 New alloy steels beat process bugaboos..... May 19 180; 11..... June 2 134
 Robbins, Martin D.
 Use nonmetallic inorganics..... Sept 8 *123
 Roberts, C. F. A.
 Siphon holds its prime..... Dec 29 *66
 Robinson, W. M. & F. H. Allen
 Flange-inserted thermowell easy to install..... Dec 1 *125
 Rodrigues, F. & J. C. Smith
 Make nomographs to find condensate film temperature..... Mar 10 150
 Rohrdanz, R. C.
 Design for lower construction costs..... Mar 24 *133
 Roos, C. W.
 How to control flow of rapid-settling slurries..... Jan 13 *168
 Rosenbaum, G. P. & D. E. Garrett
 Crystallization report..... Aug 11 *125
 Rosicarelli, Massimo
 Null device controls pulp consistency..... July 14 *153
 Ryom, A. D. & B. B. Klima
 Phase separator used for preferential sampling..... Mar 24 *148
 Sease, J. R. & A. A. Fried
 Steam trace for glass pipe..... Aug 11 *152
 Schrier, Elliot & Leslie A. McClaine
 Team effort diagnoses obsolescence..... Nov 3 128
 Scott, Donald S.
 Measure gas temperatures with a flow meter..... Nov 17 161
 Schubert, R. F. & P. J. Horvath
 Find distillation stages graphically..... Feb 10 129
 Schultz, Richard S.
 What makes a successful chemical engineer..... Mar 10 171
 Seiner, Jerome A.
 Avoid excess dilution in recovering condensates..... Dec. 29 *66
 Chart converts flow units..... Oct 20 170
 Cutting corrosion in refrigerant drying..... Dec 1 *126
 Inlet deflector reduces weak acid corrosion..... Oct 6 *154
 Level measurement in frothing liquids..... May 19 *178
 New data supplement liquid viscosity chart..... Sept 22 176
 This chart converts pressure units..... May 5 150
 Seltzer, Stanley & Robert Paxton
 Home washer doubles as pilot extractor..... Apr 7 *158
 Senn, Ronald L.
 How many tubes in an exchanger shell?..... Dec. 15 183
 Simkin, D. J. & C. O. Hurd
 Heat content and V. P. of H_2O_2 Jan 13 155
 Sisler, C. W. & D. C. Brand
 How to start a standards program..... Feb 10 141
 Skinner, E. N. Jr.
 High-temperature metals..... Dec. 15 127
 Smith, Dennis C.
 Air-cooled heat exchangers..... Nov 17 *145
 Smith, J. C. & F. Rodriguez
 Make a nomograph to find condensate film temperature..... Mar 10 150
 Smith, K. D. & D. D. Stepniewski
 Collect samples proportional to varying flow..... July 14 *152
 Snedecker, Robert A.
 Glass sink trap becomes reflux separator..... May 5 *150
 Teflon caulkings prevents leaks in threaded joints..... Oct 6 154
 Sotnick, Melvyn
 CB Cost File III..... Aug 11 151
 Srivastava, S. N.
 Eliminating air bubbles in measuring density..... Feb 10 150
 Staples, B. G.
 New resistant gaskets end sealing problems..... Oct 20 *180
 Stepniewski, D. D. & K. D. Smith
 Collect samples proportional to varying flow..... July 14 *152
 Stevens, Robley D.
 Should your employer pay you overtime?..... Dec 1 127
 Sullivan, Buckley
 Emergency leak repair is permanent..... Feb 24 *154
 Heavy handling trick for plant shops..... Jan 27 *144
 Sweeney, Robert F.
 Get relative volatility for binary solutions..... May 5 148
 Tassony, J. P. & J. M. Droter
 Speed trial and error solution for pipe diameter..... Sept 8 139
 Thomas, Jess W.
 Samples for particles in wet gas streams..... Feb 10 *148
 Tollin, Stanley
 Chart finds precoat..... Mar 24 150
 Trout, Robert G.
 How to measure individual performance..... Sept 23 173
 Putting a value on engineering work..... Sept 8 146
 Tyler, Chaplin
 How to measure management performance..... June 30 119
 Varian, I. F.
 Nomograph gives steam condensed by air..... June 2 130
 Waldron, A. James
 Mockup for instrument panels Jan 13 *164
 Weston, Roy F.
 Pollution control report..... July 14 *137
 Wiewandt, P. R.
 Build a dust hood for drum filling..... Apr 21 *166
 Wilkins, Henry Jr.
 Pollution control report..... July 14 *132
 Williams, D. C.
 Get a seven days' records on a one-day chart..... Dec 1 126
 Wilson, Glenn O.
 Thickeners and clarifiers..... June 16 *108
 Windisch, Richard P.
 Chemical industry will stay on top in plastics..... July 14 98
 Zellner, Robert J.
 Temperature recorder points doubled..... Feb 24 *154
 Ziemke, Paul C.
 Air-releasing cements cure sealing problems..... Jan 13 168
 Motor capacitors can be rejuvenated..... Jan 27 142
 Robot operator for fire door..... Aug 11 *153
 Tips on maintaining stainless steel ware..... Nov 8 146
 Zimmermann, F. J.
 New waste disposal process..... Aug 25 *117

FIRMS IN THE NEWS

R. A. LABINE

NEW FACILITIES



More Heavy Artillery for the High-Octane Battle

Three catalytic reactors above are part of a new high-severity Houdriforming unit at Tidewater Oil's Avon, Calif., refinery. Unit upgrades nearly 1 million gal./day naphthas into high-octane blending stock; reactors were fabricated by Chicago Bridge & Iron Co.

Mobay Chemical has upped manufacturing capacity for toluene diisocyanate chemicals by 50% at its Martinsville, W. Va., plant. Expansion is intended to keep pace with the rapidly growing urethane products industry. Firm also says that it is working on a new "one-shot" foaming process that will greatly simplify production of commercial urethane foam slabs.

HEF, Inc., jointly owned by Hooker Chemical and Foote Mineral, is finishing up construction on its new 4-million-lb.-yr. ammonium perchlorate

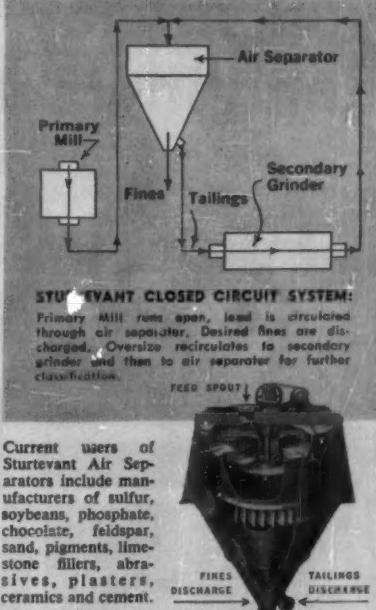
plant near Columbus, Miss. Tune-up will start in mid-January with full-scale production scheduled to get under way in February. Jointly-developed process can also turn out lithium perchlorate if missile program changes over to that oxidizer.

Coastal Chemical's \$2-million phosphate fertilizer plant at Pascagoula, Miss., is going on stream. Plant, first in U. S. to use St. Gobain's single-stage digestion process, has 75-ton/day phosphoric acid unit and 350-ton/day granulated ammonium phosphate unit under a single roof. St. Gobain process is claimed to be more compact and economical than older multistage processes. Fluor Corp. handled construction.

Allied Chemical's Barrett Div. plans to build a gypsum cal-

STOP OVERWORKING GRINDING MILLS

Boost Production of 40 to 400 Mesh Fines As Much As 300%



Sturtevant Air Separators Can Lower Power Costs Up To 50%

Production capacity impossible in single-pass grinding results from using Sturtevant Air Separators in closed-circuit grinding systems. They are of proved advantage in all secondary reduction processes.

Fines pass through grinding mills unhindered, are classified, and the oversize returns for further grinding. Grinding mills are free to perform at top efficiency, their output frequently increased as much as 300% and power costs cut up to 50% (documented by 30 years of Sturtevant air separation experience in the cement industry).

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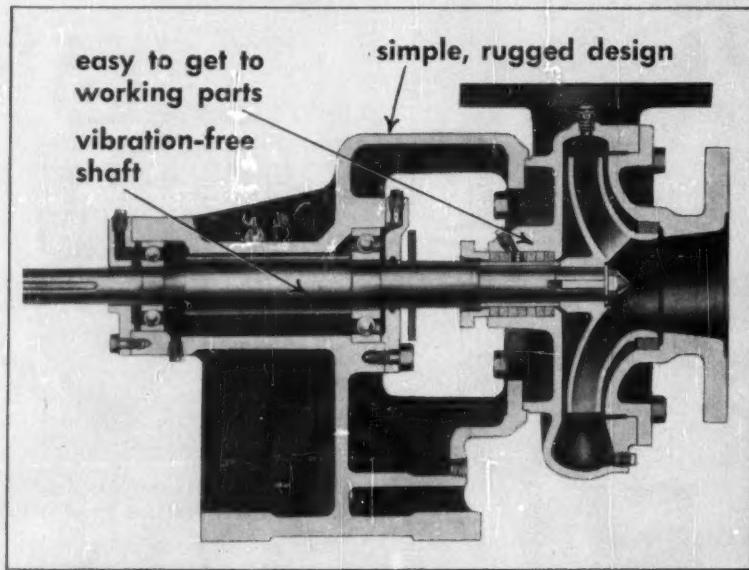
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Nine models available, diameters from 3 to 18 ft. For more information, request Bulletin No. 087. (Bulletins also available on Micronizers, Blenders, Crushers, Grinders.) Write STURTEVANT MILL CO., 100 Clayton St., Boston, Mass.

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WEINMAN PUMPS save you money in chemical handling service...



● Note, in the cut-a-way illustration above, the simplified, yet sturdy design of Weinman single-stage, end-suction pumps. The key to their low initial cost and efficient operation with little or no maintenance is the rugged, one-piece power frame combined with a neat, shipshape working head. This assures plenty of pumping power and long, trouble-free service.

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Notice, too, in the illustration above, the compact design of Weinman end-suction pumps. The result is less shaft overhang. This, and the fact that precision-machined and finished Weinman pump shafts are mounted in two oversized sealed bearings are two important reasons Weinman pump shafts are deflection and vibration-free.

You owe it to yourself to write us for descriptive Bulletin No. 500 or see your Weinman Pump Specialist. He's listed in the Yellow Pages of your telephone directory.



WEINMAN single-stage, end-suction pumps are available in capacities from 10 to 2000 gpm.

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FIRMS

cining plant adjacent to its gypsum board manufacturing facility at Edgewater, N. J. Fully automated unit will process gypsum rock direct from ships bringing ore from Nova Scotia.

Dixon Chemical is drawing up plans for a sulfuric acid plant to be erected at Paulsboro, N. J. Plant is being financed by sale of \$5.9 million of 6% debentures and 236,000 shares of common stock.

Texaco's 45,000-bbl./day refinery at Anacortes, Wash., is now on stream; catalytic cracker was the last unit to be started up. Refinery will employ a total of 310 workers when up to full capacity.

Olin Mathieson is building an integrated laboratory and pilot plant facility at New Haven, Conn., for metallurgical and nuclear fuel research. Facility, to cost approximately \$4 million, will be completed in mid-1959.

Crown Zellerbach Corp. announces that it intends to develop a "large manufacturing complex" in Louisiana as part of a long-term program to keep abreast of the southern pulp and paper industry. When CZ's new paper mill at Baton Rouge comes on stream next year, firm's total investment in Louisiana will be \$40 million.

Polymer Industries, subsidiary of Phillip Morris, is about to start an expansion program that will double manufacturing and laboratory facilities at Springdale, Conn. Firm's main products are adhesives used in making foil and other industrial laminates.

Johns-Manville has opened a new plant on Chicago's South Side to make its Dutch Brand line of pressure-sensitive tapes, adhesives and related products. Plant features a unique "combining machine" that continuously laminates strands of organic or synthetic materials on flexible sheeting.

CALENDAR

American Institute of Chemical Engineers, North Jersey Section, Topic: Oil and Chemicals from Sasol Process, Shulton Lab. Jan. 6 Clifton, N. J.

American Society for Engineering Education, Cooperative Education Midwinter Meeting, Del Prado Hotel. Jan. 8-9 Chicago, Ill.

Society of Chemical Industry, Ferkin-Medal Dinner, Waldorf-Astoria Hotel. Jan. 9 New York, N. Y.

Lehigh Valley Chemical Engineers Club, Topic: Process Instrumentation, Lehigh University. Jan. 19 Bethlehem, Pa.

Spectroscopy Society of Pittsburgh, monthly meeting, Mellon Institute of Industrial Research. Jan. 21 Pittsburgh, Pa.

American Society of Lubrication Engineers, Symposium: Lubricants for Gears, Morrison Hotel. Jan. 25-27 Chicago, Ill.

Plant Maintenance & Engineering Show, Public Auditorium. Jan. 26-29 New York, N. Y.

American Society for Engineering Education, Mid-winter meeting, University of Houston. Jan. 26-27 Houston, Texas

Canadian Pulp and Paper Assn., Technical Division, annual meeting, Queen Elizabeth Hotel. Jan. 26-30 Montreal, P. Q.

Society of Plastic Engineers, annual technical conference, Commodore Hotel. Jan. 27-30 New York, N. Y.

First International Symposium on Nuclear Fuel Elements, jointly sponsored by Columbia University and Sylvania-Corning Nuclear Corp., Columbia University. Jan. 28-29 New York, N. Y.

American Physical Society, annual meeting, New Yorker Hotel. Jan. 28-31 New York, N. Y.

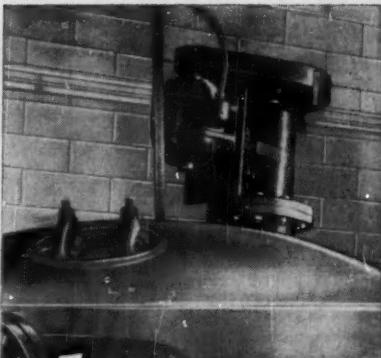
Society of Plastics Industry, Reinforced Plastics Division, annual technical and management conference, Edgewater Beach Hotel. Feb. 3-5 Chicago, Ill.

Missouri Petroleum Association, annual convention, Hotel Muehlebach. Feb. 9-11 Kansas City, Mo.

American Institute of Mechanical Engineers, annual meeting, St. Francis Hotel, Sheraton-Palace Hotel, and Sir Francis Drake. Feb. 15-19 San Francisco, Calif.

Lehigh Valley Chemical Engineers Club, Topic: Radioactive Tracers in Process Control, Lehigh University. Feb. 16 Bethlehem, Pa.

Chemical Market Research Assn., Topic: Chemicals for the Textile Industry, Dinkler Plaza Hotel. Feb. 18-19 Atlanta, Ga.

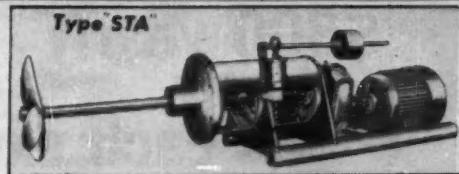


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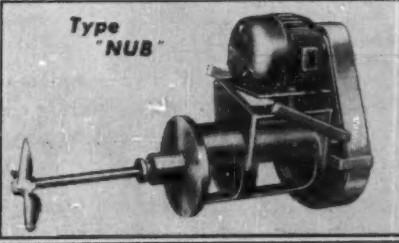


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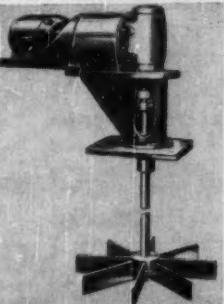
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Tech Data Pages 1283-90 C.E.C. or send for Catalog No. 83

Do-it-yourself cleaning saves chemical plant \$800 yearly on each exchanger

A midwest chemical plant, running a battery of eight 20-foot oil cooler exchangers, found its average cost per yearly cleaning of each exchanger was \$1100. Searching ways to cut costs, they called in their local Oakite man.

Here's what happened. The Oakite man studied the exchanger set-up and the type and quantity of deposits to be removed. He recommended the particular Oakite cleaning compound exactly suited to the purpose. Then—Oakite service being what it is—he donned coveralls and boots and stayed on the job supervising and testing while circulation cleaning took place on the worst exchanger of the lot.

This exchanger had been so fouled up that when it was removed from the line it made only one degree difference in temperature change. After a 24-hour cycle of circulation cleaning, it was put back in the line. Temperature change—13 degrees! The plant men who inspected it judged it to be 95% clean.

Best of all, cost of cleaning an exchanger, including time and materials, went down from \$1100 to less than \$300.

Exchanger cleaning is just one of the many chemical plant maintenance operations where Oakite can help to cut costs. For the full story, talk to your local Oakite man or write for detailed literature to Oakite Products, Inc., 16H Rector Street, New York 6, N. Y.



Technical Service Representatives in Principal Cities of U. S. and Canada

NEW EQUIPMENT . . .

(Continued from p. 40)



Automatic Xerography

New system for reproducing engineering drawings.

Xerography itself is not new. As a means of reproducing drawings and photographs onto dry, unsensitized paper, it had its start several years ago. But now, for the first time, a xerographic device called a Copyflo 24 makes it possible to complete a unitized microfilm system that quickly, accurately and inexpensively reproduces engineering drawings on a high-volume basis.

The entire system has several component parts, made by several manufacturers. Here's how the system works: Microfilm of original drawings are machine-mounted in data-processing cards. When prints are required, other machines sort and collect the proper cards, which are then fed to the Copyflo 24. This turns out the dry black-and-white prints at a rate of 20 ft./min. Maximum print width is 24 in.

Such a unitized system saves space, time, labor and materials. One company using the system cut drawing service time from 71 hr. to 16 hr. Another company lowered its drawing-reproduction staff from 43 to 23. Space savings run about 70-95%. Over-all, one of the firms expects to save \$360,000 annually.

Operation of Copyflo 24 is as follows: A beam of light scanning card-mounted microfilms projects onto a selenium-coated rotating drum, thus sensitizing its surface. As the drum rotates to a new position, sensi-

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mixes your flows on the go!

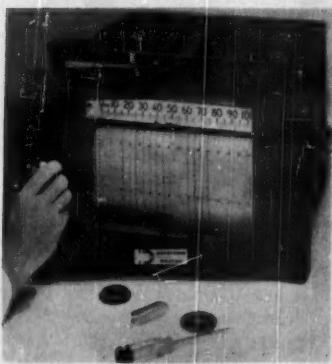
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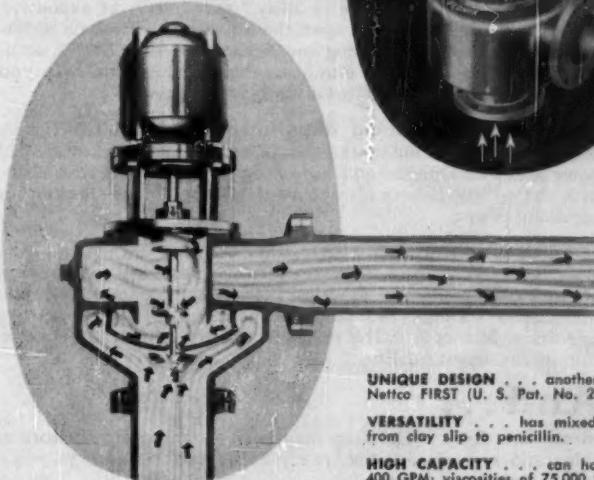
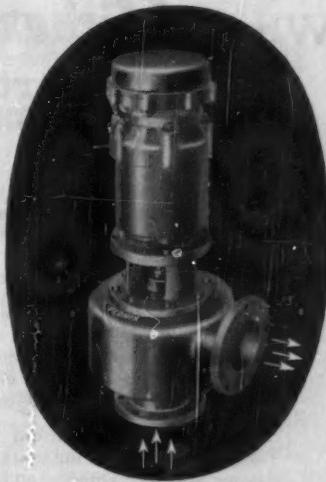


Multipoint Recorder

Plug-in adapters provide instrument flexibility.

Chief feature of the new Model 6702 multipoint recording potentiometer is flexibility of application—this single instrument can handle a variety of recording jobs without expensive refitting. For example, if the unit is in service monitoring six points, and additional work load requires scrutiny of 12 points, the operator can adapt the Model 6702 to the new requirements in just 3 min. He merely changes a plug-in unit, and replaces a dial indicator and print wheel.

Range changing requires the insertion of a proper range clip. Adaptation to newly installed transducers necessitates re-

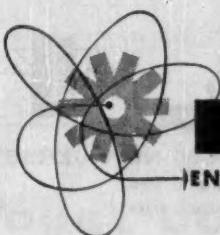


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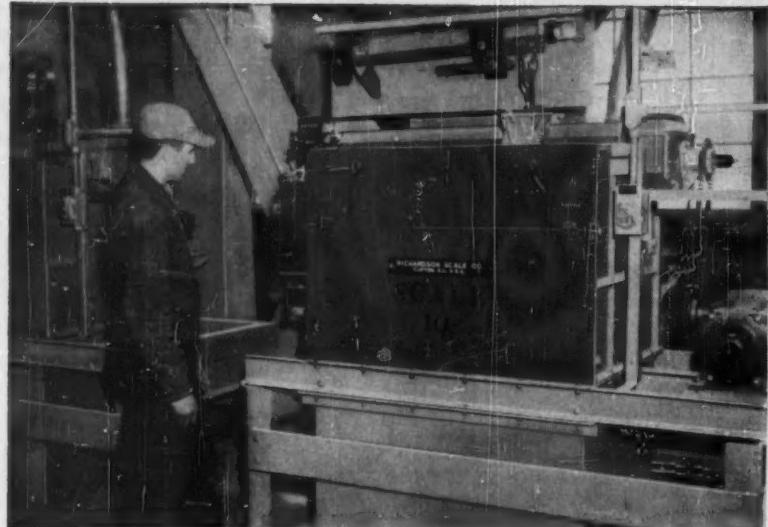
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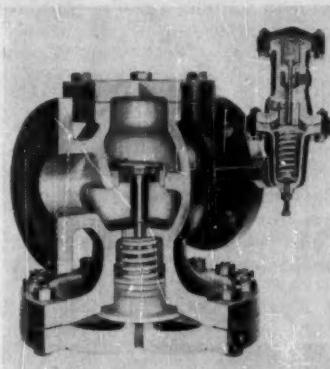
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NEW EQUIPMENT . . .

placement of the cold-junction terminal blocks. And for single point recording, a kit converts the instrument into a pen-dragging unit.

Model 6702 mounts in a standard 19-in. relay rack; it is also available for panel or wall mounting. Instrument accuracy is $\pm \frac{1}{2}\%$. — Weston Instruments, Newark, N. J. 101A



Pressure Regulator

For steam service. Has external pilot valve.

Capable of handling maximum pressures of 125 or 250 psi., Type 471 external-pilot steam pressure regulators come in 11 body sizes from $\frac{1}{2}$ to 6 in. The manufacturer claims that, in addition to accurate, fast-response regulation, the new line is suitable for tight shutoff service. A single-seat valve arrangement incorporating stainless steel valve disks and seat rings assures the positive seal in a shutoff position.

Another feature is accessibility. Installation of the pilot valve in a remote location permits quick pressure adjustments even though cramped quarters or obstacles block access to the main valve.

Type 471 regulators are designed for easy maintenance and trouble-free operation. Blind flanges on both the main valve and pilot simplify regulator teardown for inspection and cleaning. Packless construction eliminates binding problems. And, a built-in strainer protects the pilot valve.—Kieley & Mueller, Inc., Middletown, N. Y. 102A

BRIEFS

Annuclator intended for use in locations where only one or a few alarms are required, is a completely self-contained unit built around static switching circuits. Easy to install and inspect, the new unit operates on 24 to 250 v., a.c. or d.c.—Scam Instrument Corp., Chicago, Ill. 103A

Analyzer for trace oxygen possesses greater accuracy, sensitivity and stability than other commercially available instruments, according to the manufacturer. Utilizing an electrochemical-cell detecting system, the unit will measure from 0-10 ppm. to 0-1% oxygen with full-scale accuracy of about $\pm 2\%$.—Analytic Systems Co., Pasadena, Calif. 103B

In Dust Collection Systems...



SF Precipitator
at a steel plant.

design makes the difference

Equipment Cost Indexes . . .

	June 1958	Sept. 1958
Industry		
Avg. of all.....	230.7	230.9
 Process Industries		
Cement mfg.....	222.2	223.3
Chemical	231.7	232.3
Clay products	216.0	217.0
Glass mfg.....	218.8	219.3
Paint mfg.....	223.1	222.8
Paper mfg.....	223.3	223.8
Petroleum Ind.	227.9	227.5
Rubber ind.....	230.7	230.3
Process ind. avg..	228.2	228.6
 Related Industries		
Elec. power equip... Mining, milling..... Refrigeration	234.3 233.1 260.7	236.0 233.7 260.3
Steam power.....	218.4	218.1

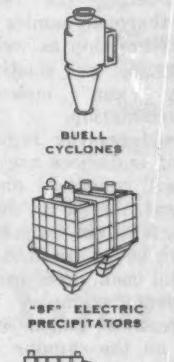
Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 125-6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143-4 for annual averages since 1913.

For More Information . . .

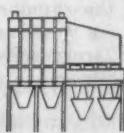
about any item in this department, circle its code number on the

Reader Service

postcard (p.105)



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T-1 STEEL AND
OTHER STEEL
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PEOPLE . . . TECHNICAL BOOKSHELF

J. B. BACON

For Two Audiences

FUNDAMENTALS OF HIGH POLYMERS. By O. A. Battista. Reinhold Publishing Corp., New York, N. Y. 140 pages. \$5.50.

PHYSICAL CHEMISTRY OF HIGH POLYMERS. By Maurice L. Huggins. John Wiley & Sons, Inc., New York, N. Y. 175 pages. \$6.50.

Reviewed by F. C. Nachod, Sterling-Winthrop Research Laboratories, Rensselaer, N. Y.

These small texts on the properties of high polymers have appeared almost simultaneously.

One written by Dr. Battista of American Viscose Corp. is essentially descriptive in nature and will serve as a quick and rapid introduction to the neophyte who has no prior knowledge of polymer chemistry.

The other, written by Dr. Huggins of Eastman Kodak is more sophisticated and is strongly mathematically oriented, covering the fundamentals of thermodynamics and kinetics of formation as well as such properties as elasticity, crystallinity and molecular weight determination.

From the foregoing remarks two types of audiences are outlined who will benefit by one or the other text. As an incidental observation, it might be pointed out that both books are authored by industrial men, and are indeed excellent examples that many fine texts no longer originate solely on the campus of a university but in the research laboratories of progressive and far-sighted commercial enterprises.

BRIEFLY NOTED

**DISTILLATION LITERATURE INDEX
AND ABSTRACTS.** 1946-1952—
595 pp., \$25; 1953-1954—412
pp., \$12.50; **VAPOR-LIQUID
EQUILIBRIUM, AZOTROPES, EX-
TRACTIVE DISTILLATION.** 1946-

1954—155 pp., \$5. **CALCULATIONS AND THEORY.** 1946-1954—125 pp., \$4. By Arthur and Elizabeth Ross. Applied Science Laboratories, Inc., 140 N. Barnard St., State College, Pa. Includes abstracts of journal papers, meeting papers, patents and books.

ELECTRONIC PROCESS CONTROL SYSTEMS. 16 pp. *Control Engineering*, 330 W. 42 St., New York 36, N. Y. 40¢. Reprint of special report in Nov., 1958, *Control Engineering* covers fundamentals, what's available in electronic control systems and electrically signaled actuators.

EVALUATED WEATHER DATA FOR COOLING-EQUIPMENT DESIGN. 88 pp. *Floor Products Co., Dept. DEW*, Whittier, Calif. \$35. Evaluated summary of hourly observations spanning 10 years at more than 400 U.S., Canadian and Mexican weather stations. Presents the 1%, 5% and 15% design levels of wet-bulb temperatures at each weather station, includes dry-bulb temperatures and wind speeds and directions coincident with high wet-bulb temperatures.

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MODERN MATERIALS: ADVANCES IN DEVELOPMENT AND APPLICATIONS. Vol. 1. Edited by Henry H. Hausner. Academic Press, Inc., New York. \$12.50.

NOMOGRAMS FOR CHEMICAL ENGINEERS. By O. P. Kharbanda. Academic Press, Inc., New York. \$15.

INTERNATIONAL COMMITTEE OF ELECTROCHEMICAL THERMODYNAMICS AND KINETICS—Proceedings of the Eighth Meeting. Butterworth & Co. (Canada) Ltd., Toronto. \$19.

PRINCIPLES OF HEAT TRANSFER. By Frank Kreith. International Textbook, Scranton, Pa. \$11.

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13	35	37E	41	80	101A	108C	108L	108U	109H	110c	1112b	113D	114G	124
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Biochemicals Processing—The total picture (50¢)	93
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Thermodynamic Principles (50¢)	42
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TECHNICAL LITERATURE

EDITED BY E. M. FLYNN

Contents of This Issue

Chemicals & materials	108
Construction materials	108
Electrical & Mechanical equipment	103
Handling & Packaging	109
Heating & Cooling	109
Instruments & Controls	110
Mechanical equipment	103
Pipe, fittings, valves	110
Process equipment	111
Pumps, blowers, compressors	113
Services & processes	114

Chemicals

Activated Carbon Many heavy chemicals with rigid specifications can be purified economically with Darco . . . whether problem is color, odor, etc.

25 *Atlas Powder Co., Chem. Div.

Adhesive . . . 8 p. brochure discusses company's new 910 adhesive, a cyanoacrylate said to form remarkably rapid and strong bonds between wide variety of materials.

108A Eastman Chemical Products

Alloy . . . 2 p. technical data card, TDC-189, tells of high temperature properties of B&W Croloy 16-13-3, chemical composition, size ranges, tensile & rupture properties.

108B Babcock & Wilcox Co.

Ammonia . . . 40 p. bulletin tells of purchasing, handling, storage, and uses. Photos, tables and figures illustrate sections on both aqua and anhydrous.

108C Pennsalt Chemicals Corp.

Caustic Soda . . . 26 p. profusely illustrated handbook includes basic information on the various commercial forms of caustic soda. Details handling procedures.

108D Stauffer Chemical Co.

Chemicals . . . 3 p. tabular brochure contains data on such products as phosphorus, phosphoric acid, sodium phosphates, organic phosphates and sodium chloride.

108E Electric Reduction Sales

Chemicals . . . A new 27-page booklet on Physical Properties of synthetic organic chemicals is offered. Fifty-seven new chemicals appear in this edition for the first time.

108F Union Carbide Chemicals Co.

Chemicals, Aromatic . . . Newest issue of company's semi-annual price list, 36 p., is dated October 1958. Descriptions and market information cover aldehydes, gums oleoresins.

108G Dodge & Olcott, Inc.

* From advertisement, this issue

Filteraid . . . Neofil, carbon-based filteraid for difficult filtrations such as caustic or fluorated solutions. Available in 6 grades. An illustrated bulletin is offered.

111 *Great Lakes Carbon Corp.

Formaldehyde . . . 29 x 19 in. wall chart includes minimum storage temperatures, flash points, first aid information, analytical methods, testing procedures.

108H Borden Chemical Co.

Formaldehyde . . . 6 p. brochure gives complete specifications for 37% and 44% inhibited and uninhibited formaldehyde solutions, plus other general information.

108I Borden Chemical Co.

Formaldehyde . . . Two seminar papers prepared by company experts cover the salient physical & chemical properties, engineer, safety, control for handling.

108J Borden Chemical Co.

Furfural . . . In wide use as a selective solvent. Effective in separation of organic sulfur compounds, or heavy metal complexes from petroleum fractions. Bul. 203-A.

33 *The Quaker Oats Co., Chem. Dept.

Olefins . . . Complete information on specifications & characteristics of Tetrapropylene & Tripropylene & many other high quality petrochemicals is available.

75 *Enjay Company, Inc.

Packing Material, Plastic . . . 32 p. bulletin describes Dowpac, company's new plastic packing material used in biological oxidation of industrial wastes.

108K Dow Chemical Co.

Propellents . . . Of particular value to aerosol fillers, 4 p. bulletin contains complete vapor pressure tables and other useful technical data on company's Isotron line.

108L Pennsalt Chemicals Corp.

Construction Materials

Alloys . . . How to fabricate "Hastelloy" alloys is the subject of a new 36-page booklet. Covers step-by-step procedures & recommendations for welding, forging, forming etc.

108M Haynes Stellite Co.

Bus Bars, Aluminum . . . feature excellent corrosion resistance. For use in process plants. Complete information contained in Bus Conductor Handbook, AD661.

108N Aluminum Co. of America

Castings, Stainless . . . A 28-page booklet of valuable & complete data on stainless castings. Included analyses, properties, technical data on handling & heat treatment.

41 *Allegheny Ludlum Steel Corp.

Coatings, Resin-based . . . guard paint production equipment from corrosion. Booklet, "Epon Resin Esters For Surface Coatings" is now available.

Cover *Shell Chemical Corp.

Stair Treads, Aluminum . . . are available in all standard sizes. They need no paint. Aluminum grating also available, for floors & walkways. Bulletin AD679.

108O Aluminum Co. of America

Steel and Aluminum Data . . . New edition of 256-page handbook includes analyses, characteristics, mechanical properties and tolerances for aluminum and steel.

108P Joseph T. Ryerson & Son

Tread Plates . . . available in standard aluminum and also bonded abrasive surface for extra non-skid protection. Complete information in Bulletin AD596.

108Q Aluminum Co. of America

Vacuum Retorts . . . used for high-temperature vacuum annealing. Facilities & skills cover a wide range of tanks, furnace retorts, tanks & other fabrications.

B121 *Rolock Inc.

Electrical & Mechanical

Air Motors . . . New bulletin covers over 100 popular Air Motors in the manufacturer's line. Power range from 0.3 to 24 hp. with speeds from 50 to 2,580 rpm.

108 R Ingersoll-Rand Co.

Control & Indicating Stations . . . New threaded-joint, neoprene-sealed stations afford safety for pilot lights, heavy-duty push-button stations, selector switches, etc.

18 *Crouse-Hinds

Floodlights . . . New catalog provides adequate descriptive and ordering information on manufacturer's line of floodlights. Includes "How to Select Floodlights."

108S Crouse-Hinds Co.

Fluid Power Equipment . . . Specifications, illustrations and descriptive matter on the complete line of Oilgear and Servocontrol Div. equipment given in Bul. 10051-G.

108T The Oilgear Co.

Gas Turbines . . . Bulletin 167 details operating experience with the Mark TA 750/1000 kw. gas turbine. Design features, fuels and application information.

108U Clark Bros. Co.

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LITERATURE . . .

Handling & Packaging

ASME Boiler Code . . . A handy wall chart titled "Quick Reference Guide to ASME Boiler and Pressure Vessel Code (Section VIII)" is available on request.

109A Missouri Boiler and Tank

Comparators . . . for fast, accurate pH, Chlorine, phosphates or nitrates test. Handbook, "Modern pH & Chlorine Control", gives theory & application.

120 *W. A. Taylor & Co.

Conveying Systems . . . Air-line conveying provides fast, sanitary method of unloading, implant transporting, mixing, & loading any dry materials. Bulletin No. M-588.

109B The Day Company

Drums . . . Alloy metal, stainless steel, & nickel & monel drums are featured. Offer protection against product discoloration, chemical changes & corrosive action. Details.

13 *Pressed Steel Tank Co.

Hand Trucks . . . Booklet tells how walkie-type trucks give one hand the power to move tons, and helps to determine which operator-led trucks are best for the job.

109C Automatic Transportation

Handling Devices . . . For the handling of radioactive, toxic or highly flammable materials. Manufacturer produces line of remotely controlled handling devices.

109D General Mills, Inc.

Scales, Bulk . . . are important to you in your receiving department . . . in profit control . . . in cost accounting dept . . . in batch proportioning & quality control.

102 *Richardson Scale Co.

Transports . . . for the chemical & process industries. Illustrated Bul. No. 257-T gives details on transports available for every liquid hauling purpose.

109E Doyle & Roth Sales Corp.

Vibrating Conveyors . . . Designs and dimensions for three new high-temperature vibrating conveyors are the topics of the manufacturer's Model HT catalog.

109F Carrier Conveyor Corp.

Heating & Cooling

Combustion Draft . . . Bulletin gives the what, where, how and why of draft as it affects the efficiency of combustion processes. Also details on draft gages.

109G Hays Corp.

Coolers, Packaged . . . specifically designed to produce chilled liquids in volume. Bul. No. 257-C illustrates four types for unusual cooling requirements.

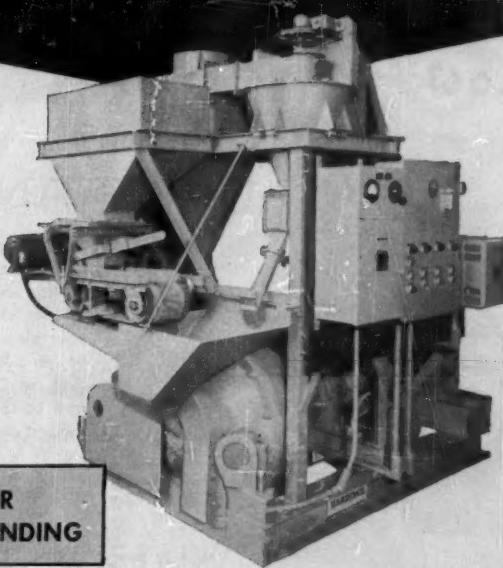
109H Doyle & Roth Mfg. Co., Inc.

Heat Transfer . . . Bulletin 123-6 contains product information and selection data for storage water heaters and heat exchangers. Easy-to-use tables.

109I Patterson-Kelley Co.

* From advertisement, this issue

PACKAGED PULVERIZERS



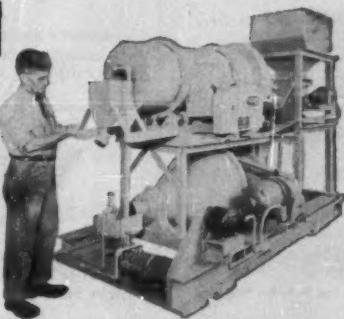
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FOR WET GRINDING

Hardinge builds a similar unit (right) for small-scale wet-grinding applications. The "package" includes mill, classifier, feeder, "Electric Ear", and launders.

Bulletin AH-448-11

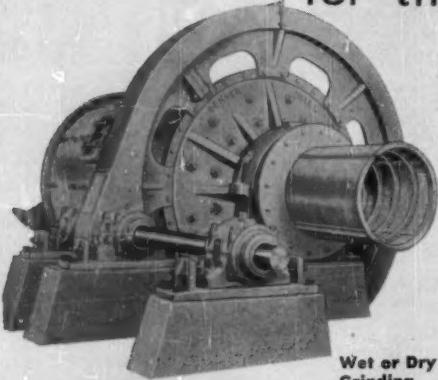


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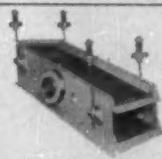
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LITERATURE . . .

Instruments & Controls

Dial Thermometers A complete line is available with wide temperature ranges, dial sizes, patterns and finishes. A new catalog covers all details.

T112c *Marsh Instrument Co.

Industrial Control Bulletin 958 illustrates manufacturer's line of industrial control devices. It also introduces a line of speed-responsive switches.

T110A Euclid Electric & Mfg.

Manometers Catalog 2008 gives full details and specifications on a redesigned and expanded line of well-type manometers for pressure, vacuum and differential service.

T112B King Engineering Corp.

Needle Throttling Valves gives micrometer regulation at high pressures. Pressure up to 10,000 psi and any temperature up to 500 F. Catalog available.

T112b *Marsh Instrument Co.

Pressure Gauges combine features of pressure vacuum and compound gauges. There is a gauge for every conceivable application. New catalog for details.

T112a *Marsh Instrument Co.

Stream Analyzers Bulletin CL-4000 includes information on the most complete line of process stream analyzers available from any one source, according to manufacturer.

T110C Beckman/Scientific

Pipe, Fittings, Valves

Fittings Complete dimensional data on a full line of stainless steel soldering fittings and flanges is contained in revised catalog. Updated technical data.

T110D Tube Turns

Pipe, Plastic Precision molded pipe & fittings for every corrosion & flow problem include tees, couplings, flanges, reducing bushings, plugs, etc.

71 *U. S. Rubber Co.

Pipe, PVC comes in sizes from $\frac{1}{4}$ inch to 14 inches in diameter, & in schedules A, 40, 80 & 120. It does not contaminate sensitive solutions. Bulletin No. 24.

80 *U. S. Steel, National Tube Div.

PVC pipe and fittings Brochure anticipates and answers the problems and questions most likely to arise when working with PVC pipe and fittings.

110E Mueller Brass Co.

Thermo Panels take the place of pipe coils. Can be quickly installed or removed for cleaning. Complete data, including prices is available. Send for your copy.

TR121 *Dean Products, Inc.

Valves New Gate & Globe are available from stock in $\frac{1}{4}$ " thru 2" sizes & in both socket weld & screw ends. Feature hard faced seats & hardened discs & wedges.

50 *Henry Vogt Machine Co.

* From advertisement, this issue

LITERATURE . . .

Valves, Diaphragm . . . for handling viscous materials—semifluid foods, latex, magnas; solids in suspension-slurries, pulp stock, sludges; fluid-borne abrasives, etc.
14 *Grinnell Company, Inc.

Valves, Stainless . . . Bulletin 3 describes a line of jacketed stainless steel valves designed for fluids difficult to move at room temperatures. Send for your copy.
111A Alloy Steel Product Co.

Valves, Stainless Steel . . . Aloyco valves offer staying power, minimum maintenance & corrosive service. Other types, alloys, sizes & pressures available.
1 *Alloy Steel Products Co.

Process Equipment

Agitator . . . The Flomix can handle over 400 GPM; viscosities of 75,000 SSU; pressures over 400 PSI; temperatures to 300 C. Complete details in Bul. No. 531.

101 *New England Tank & Tower Co.

Agitators . . . Turbine propeller type for effective agitation in tanks as large as 50' diameter. Details on agitators for repulping, mixing, scrubbing, etc. in Bul. A2-B6.

39 *Denver Equipment Co.

Agitators and Mixers . . . available in sizes 32" x 32" and larger. They are engineered to your individual requirements. Details contained in Bulletin No. AT-B4.

110c *Denver Equipment Co.

Automatic Samplers . . . with 8" to 120" Cutter Travel are described in Bulletin No. SI-B4. They are part of a complete line of size reduction equipment available.

110f *Denver Equipment Co.

Blenders . . . Specialized information and complete data contained in Bulletin No. 16, Chemical Process Equipment & Bulletin No. 15A-1, Twin-Shell Laboratory Blenders.

20-21 *Patterson-Kelley Co.

Cabinet Cloth Filter Collector . . . Model 81 requires only 28" x 28" floor space & provides cloth filtering area of 150 sq. ft. Complete details available.

111B Torit Mfg. Co.

Crystallizer . . . designed to meet your requirements, both as to construction materials & capacity. A new technical paper containing valuable facts is offered.

35 *Swenson Evaporator Co.

Dissolvers . . . for ultimate dispersion, dissolving, emulsifying & deagglomerating in processing solid-liquid, liquid-liquid & gas-liquid materials. Information in catalog.

23 *Morehouse-Cowles

Dryers . . . Lectodryers stretch periods between defrosting . . . cut processing slowdowns & extend heat exchanger life. A detailed questionnaire is offered.

10 *Pittsburgh Lectodryer Div.

Dryers, Rotating Vacuum . . . is available in six sizes and include provisions for steam or hot water heating. Complete information & application data available.

47 *F. J. Stokes Corp.

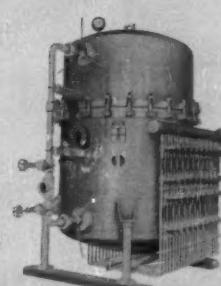
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IMPROVED

Nerofil

The Carbon-Based Filteraid for
"Difficult" Filtrations such as
Caustic or Fluorated Solutions



Now Available in 6 Grades to Meet All Needs for High Clarity and Fast Flowrate...using Your Regular Filtration System—Pressure, Vacuum, or Rotary Vacuum Precoat Filters

 Check these NEROFIL Advantages!

Not just crushed carbon, but a genuine filteraid specially processed for greater porosity and maximum surface area, NEROFIL is giving excellent results where no other filteraid had ever been entirely satisfactory.

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FILTERAID SAVINGS UP TO 20% because of Nerofil's lower cake density and high porosity.

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Excellent for Filler use, too

TREMENDOUS SURFACE AREA of Nerofil, plus its other properties, give it definite advantages as a filler in resins, cements, etc., as a catalyst carrier, in foundry applications and other uses.

USE COUPON FOR FREE ILLUSTRATED BULLETIN

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333 No. Michigan Ave., Chicago 1, Ill.

Yes, I'd like information on Nerofil for Filtration Other Use

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Company _____

Address _____ City _____ Zone _____ State _____

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and missile industry...**

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MARSH *New catalog covers all details*

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Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta,
Canada. Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas

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Produces Finished Product
in One Operation

Est. 1870

TROY

*Trademark—Patent Pending

A flexible compact unit that combines a powerful disperser head with a rugged diamond-shaped agitator to produce finished homogeneous batches without further processing—for most chemicals, inks, plastics, pharmaceuticals, cosmetics, paints, and industrial finishes.

Modern design gives high degree of shear, kinetic impingement, and complete mulling action for better wetting, improved dispersion, and uniform blending. Small size laboratory models available.

SEND SAMPLES OF YOUR MATERIALS FOR TRIAL PROCESSING. No obligation. Write TODAY for new 1958 TROY Processing Equipment Catalog, fully describing the Troy Line of Angular Mixers, Colloid Mills, Roller Mills and Unit Blenders.

TROY ENGINE & MACHINE CO.
12-28 Parsons Street, Troy, Pennsylvania Tel: Troy 32

LITERATURE . . .

Dust Collector.....The Ventrijet wet dust collector is particularly suited to collecting hot, moist, inflammable, corrosive & obnoxious dusts. Details in Bul. 922.

16 *Pangborn Corp.

Dust Collectors.....Illustrated folder gives details on models for gritty dust, for bulky or sticky dust & special models & equipment for every need.

112A *Torit Mfg. Co.

Feeders, Airlock.....available in standard duty, heavy duty, & blow-thru types. Booklet P-58, "How to Select A Rotary Airlock Feeder", is offered.

1114 *Prater Pulverizer Co.

Filter.....Tilting Pan, Horizontal Vacuum Filter provides multi-stage counter-current wash with complete separation of wash liquors from mother liquor.

4 *Bird Machine Company

Filter Papers.....free from linen & minerals. They are made under controlled conditions. Types for every need. Sample filter papers are available.

TL121 *The Eaton-Dikeman Co.

Filters, Disc.....The Agitator-type disc filters are available in sizes to 9" diameter x 12 disc. Bulletin No. F9-B5 gives full particulars on this type.

110e *Denver Equipment Co.

Filters.....offer safe, effective filtering protection for your equipment. Available in a wide range of types & sizes. Descriptive literature offered.

113 *Wm. W. Nugent & Co., Inc.

Homogenizers.....handle all kinds of emulsions and fit into any plant. Feature easy cleaning & maintenance, tight emulsions, no aeration & faster emulsification. Bul. 157.

112B *Sonic Engineering Corp.

Jaw Crushers.....Bulletin No. C12-B12 gives complete details of this unit for the chemical process industries. Available in sizes from 2 1/4" x 3 1/4" to 32" x 40".

110a *Denver Equipment Co.

Mills, Ball & Rod.....for wet or dry grinding. Feature cast steel or Mechanite heads, large diameter trunnions, & single helical cast steel gear & pinion, etc.

12 *Kennedy Van Saun

Mills, Steel Head.....Bulletin No. B2-E20 offers complete information on steel head mills available in sizes up to 10' diameter x 20' long, for your needs.

110g *Denver Equipment Co.

Mixer, Batch.....produces finished product in one operation. A new catalog describes the Troy line of angular mixers, colloid mills, roller mills & unit blenders.

1112 *Troy Engine & Machine Co.

Mixers.....You'll find a wealth of information on fluid mixing in helpful bulletins describing Lightnin Mixers. These mixers adapt to changes in your process.

124 *Mixing Equipment Co.

Mixers.....Literature is available on the Simpson Mix-Muller which features a unique three-way kneading, smearing, spatulate action. You get mix that stays mixed.

48 *National Engineering Co.

* From advertisement, this issue

LITERATURE . . .

Mixers. Portable . . . features high speed, slow speed & intermediate. Production & Laboratory models are available. Complete details in Special Bulletin 74B.
99 *International Engineering, Inc.

Precipitators. A 22-page booklet gives full information on SF electric precipitators. Feature low installation & maintenance cost in dust collection systems.
103 *Buell Engineering Co., Inc.

Process Equipment. Illustrated bulletin on change can mixers, roller mills, kneaders, rubber cement mixer, heavy-duty liquid mixers & High speed dissolver.
113A Charles Ross & Son Co., Inc.

Processor. Vacu-Film processor simplifies complex & difficult processing problems, particularly on time-at-temperature sensitive materials. Details in Bul. PE-98.
113B Rodney Hunt Machine Co.

Pulverizers, Packaged. Two units are featured. One for small-scale continuous dry grinding and one for small-scale wet-grinding. Details on both units in Bul. AH-44B-11.
109 *Hardinge Company, Inc.

Screens. The Denver-Dillon screens in sizes 1" x 3" to 6" x 14" are outlined in Bulletin No. S3-B15. Especially designed for the chemical process industries.
110d *Denver Equipment Co.

Pumps, Blowers, Compressors

Air Filter. For compressed air systems has a dual cleansing principle and uses an interchangeable throw-away filter cartridge. For 10, 25 and 40 microns.
113C Perfecting Service Co.

Air Separators. Circulate production loads of up to 800 tph. Nine models available with diameters from 3 to 18 ft. Information contained in Bul. 097.
97 *Sturtevant Mill Co.

Compressors. The Class FE compressor is one of several types available for process work. Suitable for direct motor drive or gear drive in sizes to 5,000 hp.
6-7 *Chicago Pneumatic

Compressor, Rotary. A new bulletin describes the new 365-cfm. rotary portable air compressor. Photos illustrate features of the unit, which runs at 1,100 rpm.
113D Le Roi

Pumps. The SRL pumps have a capacity to 3000 g.p.m. Bulletin No. PB-B10 features complete information on the design for your special requirements.
110b *Denver Equipment Co.

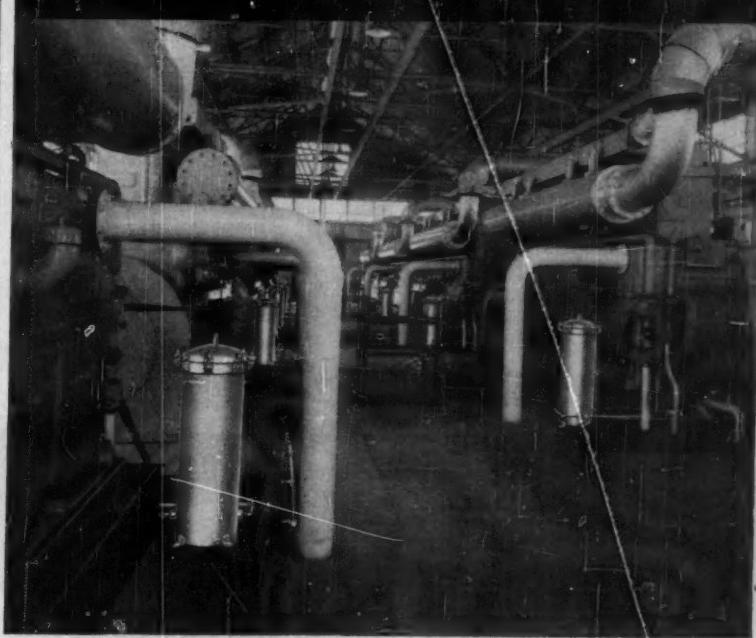
Pumps. Corrosion-resistant pumps feature slot & pin device which keeps stainless steel sleeve & shaft rotating together. Also reusable rubber pump head.
73 *Waukesha Foundry Company

Pumps. Single-stage, end suction pumps are available in capacities from 10 to 200 gpm. Feature vibration-free shaft. Descriptive Bulletin No. 500 is offered.
98 *The Weinman Pump Mfg. Co.

* From advertisement, this issue

NUGENT FILTERS

Keep Lube Oil Clean
for El Paso Natural Gas Company



Twenty-seven gas engine compressor units, each equipped with a Nugent Lube Oil Filter, have been in service at the Goldsmith plant of El Paso Natural Gas Company since 1949.

Excellent bearing, ring and cylinder wear maintenance records are positive proof that Nugent Filters have performed an outstanding job in keeping lube oil clean . . . free from sludge, acidity and harmful impurities that can accelerate wear and shorten engine life.

For safe, effective filtering protection for your valuable equipment . . . always specify Nugent Fuel and Lube Oil Filters . . . available in a wide range of types and sizes. Write for descriptive literature.



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OIL FILTERS • STRAINERS • TELESCOPIC OILERS
OILING AND FILTERING SYSTEMS • OILING DEVICES
SIGHT FEED VALVES • FLOW INDICATORS

PLASTICS 1959

INTERNATIONAL TRADE FAIR OF THE INDUSTRY

October 17-25, 1959
Duesseldorf/West Germany

For complete information write: NOWEA, Nordwestdeutsche Ausstellungs-Gesellschaft m. b. H., Duesseldorf, Ehrenhof 4, Telephone: 44041, Cable Address: NOWEA, Duesseldorf

For information in USA:
German-American Trade Promotion Office
350 Fifth Avenue, New York 1, N. Y.
Telephone: Wisconsin 7-0727

PRATER CAN Solve YOUR! AIRLOCK FEEDER PROBLEM!

More than 2000 different Prater Airlock applications have solved processing requirements for 300 concerns. You'll find there IS a Prater Airlock for your need . . . from low pressure dust control to high pressure pneumatic conveying.

STANDARD DUTY

Principally adapted for sealing off collectors against air leakage.

Four Sizes . . . 6", 8", 10" and 12".



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For applications involving high pressure Pneumatic Conveying or Volumetric feeding of finely ground materials.

Four Sizes . . . 6", 8", 10" and 12".



BLOW-THRU

For pneumatic conveying systems handling flour or similar fine powder or granular material. Available for 2", 3" or 4" Conveying Lines.



Send for informative Booklet P-58
"How to Select a Rotary Airlock Feeder"

Foremost Builder of Rotary Airlock Feeders

PRATER PULVERIZER COMPANY

1517 SOUTH 55TH COURT

CHICAGO 50, ILLINOIS

LITERATURE . . .

Pumps, Process . . . The complete range offers all types of chemical process pumps, in all sizes & frames. Bul. EM-79, "Mechanical Consideration in Pump Design" is offered.

46 *Food Machinery & Chemical Corp.

Traps, Steam . . . The 44-page, "Steam Trap Book" covers the excellent air handling characteristics & other features. Gives details on selection & installation.

11 *Armstrong Machine Works

Services, Processes, Misc.

Alignment Chart . . . Free 8½ x 11 in. alignment chart gives the log mean temperature difference if initial and final temperature differences are known.

114A Dean Products, Inc.

Analytical Methods . . . Paper describes an improved method of determining acids and basic nitrogen compounds in petroleum products. It's simpler, faster.

114B L. Sonneborn Sons, Inc.

Cryogenics . . . 12 p. brochure describes engineering and construction facilities serving fields of ground support for missiles, cryogenic engineer & nuclear engineering.

114C Stearns-Roger Mfg. Co.

Disinfectants . . . Manufactured products for promotion of health & sanitation. Research with insecticides, soap, etc. Literature available with complete information.

114D West Chemical Co.

Exchanger Cleaning . . . Detailed literature on this cleaning process and other chemical plant maintenance operations is available on request. Send for your copy.

100 *Oakite Products, Inc.

Filter Area Calculator . . . New slide-rule type filter area calculator determines required filter area on basis of both filtration rate and the cake capacity.

114E Niagara Filters

Kerr Cell Shutter . . . Electro optical device designed especially for ultra high speed photography. Ideally suited for chemical reactions, explosion phenomena, etc. Bul. 4.

114F Avco Manufacturing Corp.

Rotating Drum Camera . . . for accurate recording of hypervelocity phenomena. Other applications are radiation studies, chemical recombination, etc. Bul. No. 9.

114G Avco Manufacturing Corp.

Rotating Mirror Camera . . . for accurate position versus time recording of hypersonic events. Bul. No. 8 outlines application, camera construction & operation.

114H Avco Mfg. Corp.

Structures . . . Facilities for the design, fabrication & erection of standard or special steel plate structures. Complete details in Field Services booklet.

69 *Chicago Bridge & Iron Co.

Tank Calculator . . . Pocket-size slide rule determines capacity and size of storage tanks up to 100 ft. high and 300 ft. diameter. Capacities in gal., bbl. and lb.

114I Hammond Iron Works

* From advertisement, this issue

PROFESSIONAL SERVICES

ARIES ASSOCIATES, INC.
Consultants to the Chemical Industries
 New Products and Processes
 New Product Development
 Design & Initial Operation of Chemical Plants
 Process Analysis—Market Research
COMPLETE TECHNICAL & ECONOMIC SERVICES
 77 South St. DA. 5-2236 Stamford, Conn.

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CHMICAL ENGINEERS
 Evaporation, Crystallization and Heat Transfer;
 Complete plants for salt and caustic soda; Complete
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CHAS. T. MAIN, INC.
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 Industrial Plants
 Reports Design Construction Supervision
 88 Federal Street Boston 10, Mass.
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The Consulting Engineer

"By reason of special training, wide experience and tested ability, coupled with professional integrity the consulting engineer brings to his client detached engineering and economic advice that rises above local limitations and encompasses the availability of all modern developments in the fields where he practices as an expert. His services, which do not replace but supplement and broaden those of regularly employed personnel, are justified on the ground that he saves his client more than he costs him."

CLASSIFIED . . . EMPLOYMENT OPPORTUNITIES

CE's nation-wide coverage brings you tips and information on current opportunities in job functions throughout the chemical process industries.

► Coverage — National Executive, management, engineering, technical, sales, office, skilled. Positions vacant, positions wanted, civil service, selling opportunities, employment agencies and services, labor bureaus.
 ► Displayed Rates — \$46 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured 1 in. vertically on a column; 3 columns, 30 in. per page. Subject to the usual agency commission.

► Undisplayed Rates — \$2.10 per line, 3 lines minimum. To figure advance payment count 5 average words as a line; box number counts as 1 line, 10% discount if full payment is made in advance for 4 consecutive insertions. Not subject to agency commission.

► Closing Date — January 26th issue closes January 3rd. Send new ads to Chemical Engineering, P. O. Box 12, New York 36, N. Y.

MANAGER

To manage sales, design and estimating division for process equipment manufacturer in East. Chemical engineering education desirable. Know ASME Code work. Experience with manufacture of process equipment preferred. Should know steel, stainless, aluminum and alloy fabrication, machining and welding.

Excellent opportunity for industrious, personable manager—salary open. Send resume

P-9459, Chemical Engineering
 Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

CHEMICAL ENGINEER

OVERSEAS LIAISON

Several years' experience in the selection, layout and installation of chemical processing equipment. Occasional overseas trips of short duration. Permanent position offering exceptional opportunities for experience and advancement with world-wide pharmaceutical firm. Age about 35, college degree required.

Send resume, references and minimum salary requirements to:

P-9449, Chemical Engineering
 520 N. Michigan Ave., Chicago 11, Ill.

SELLING OPPORTUNITY OFFERED

Manufacturer of Heat Exchangers and Pressure Vessels, located in New Jersey, wants sales representatives in various parts of country. Representatives should have contacts in oil refineries, power plants, chemical plants or marine: RW-8806, Chemical Engineering, Class. Adv. Div., P. O. Box 12, New York 36, N. Y.

An employment advertisement in this EMPLOYMENT OPPORTUNITIES section will help you find the engineers you need. It's an inexpensive, time saving method of selecting competent personnel for every engineering job.

Engineering Editors

Opening on Chemical Engineering's editorial staff for engineers to solicit, evaluate and edit articles on chemical engineering methods, practices, trends and equipment. Unusual opportunity to broaden contacts, education and experience. Requirements: Degree in chemical engineering with thorough knowledge of fundamental principles; up to five years of engineering experience; interest in instrumentation, process development or design; ability to evaluate engineering information; able to write clearly and accurately; must work well with people; initiative and imagination. New York City location. Send resume of experience, salary requirements and all other pertinent information to:

John R. Callahan, Editor-in-Chief
 Chemical Engineering
 330 West 42nd Street
 New York 36, New York

CHEMIST

SALARY \$9,500 PER YEAR
 Minimum 2 years experience in resin emulsion technology, preferably PVAC emulsions along with paper coating and machine experience. Company client assumes all employment expenses.

MONARCH PERSONNEL
 28 East Jackson, Chicago 4, Illinois

WANTED

Manufacturers' Representatives to sell to Chemical Processors and others the new high-production CoqMill that will reduce almost any material to any size or blend any combination of solids, emulsions or liquids to any consistency.

Write now for full particulars.

THE COG CORPORATION

Division of Motigraph, Inc.

Established 1896

4441 W. Lake St., Chicago 24, Ill.

FIRST Class Equipment

FROM YOUR FIRST SOURCE

RUBBER and PLASTIC UNITS

- * Battery of NEW UNUSED 14" x 30" Two Roll Farrell-Birmingham Mills with UNI-Drives
- * Line of F-B. Mills 42" and 60" Rolls
- * Stewart Rolling 2 Roll Mill 8"x16"
- * Multi Plate Hydr. Presses 24" x 56" with (2) 10" Rams; 3000 PSI
- * Erie Jacketed Extruder 6" x 66"
- * Battery of Horizontal Sheeters Hydraulic 26" wide Knife
- * Oswego Cutter 63" wide with 10 HP
- * Ball & Jewell Rotary Cutter 10 HP
- * 425 Ton Horizontal Hydraulic Sheeting Extruder complete . . .
- * Baker Perkins Heavy Duty Dbl. Arm Jacketed Mixers; 300 Gal. 200 Gal. 100 Gal. and others; Several Cavagnaro Mixers in Stock too

MILLS AND GRINDERS

- Mikro Pulverizers; all sizes from Bantam to No. 4
- Mikro Atomizers; Stainless Lined; No. 5 and 6 International Porcelain Mills. Pebbles Mills 8"x16" Abbe and Patterson Pebble Mills from 36"x42" to 6"x42"
- Abbe Sixx Lined Ball Mills; 5"x14" and 5"x16"
- Patterson JACKETED Ball Mills; 54"x42"
- 1000 Gal. Jacketed Buhrlstone Lined Pebble Mill; 6"x6"; 25 HP
- Simpson Intensive Mix-Millers 24", 36" and 72"

CENTRIFUGALS

- A. T. & M. 26" Stainless Suspended Type
- A. T. & M. Rubber Cov. 30" Susp. Centrifugal; Tolhurst 30" S/S Suspended; with Plow and Bottom Dump
- A. T. & M. 60" S/S Suspended center auger; Vapor tight
- Sharples H2 Super-D-Center; 10 HP
- Sharples H2 Nozzlejector; 1000 GPH
- Sharples C20 Super-D-Hydrator in 316 Stainless; Bird Solid Bowl Continuous Centrifuge 32"x30"; 316 S/S

FILTERS

- Dorree Rot. Vacuum Filter; 6"x3" with nickel contacts
- Feine S/S Rot. Vacuum Filter 5"x6" complete
- Oliver Pre-Coat Rubber Lined Filter 8"x8"; 200 sq. ft. area

DRYERS

- Hershey Rotary Gas Fired Dryer 5"x26" Counter Current complete
- S/S Lined Rotary Dryer 30"x20" with Burner, Combustion Chamber, etc.
- Stoker Rot. Jkted. Dryer 18"x8"
- Bagley & Sewell Double Drum Dryer 28"x60"
- Buffalo Dbl. Drum Dryer 40"x120" with accessories
- Struthers Well Stainless Drum Dryer 4"x5"

REACTORS—EVAPORATORS

- New 8/8 125 Gal. Reactor; 30"x30" Jacketed; Agitated; motorized
- Pfaudler Glass Lined Reactors 500 gal., 1,000 gal. Blaw Knox Stainless Reactor 76"x76"; Jacketed, 1500 Gal. Steel Jacketed and Agitated Heavy Duty Reactor
- Smith Stainless Lined 11,000 Gal. Pressure Tanks Rotating Jacketed Aluminum Vacuum Fermenter; Mojonier 8/8 Vac. Pans 3"x10' and 6"x12'
- Harris Stainless Vacuum Pan 6" Dia. with coils Zaremba Dbl. Effect INCONEL Evaporator 430 sq. ft. surface
- Swenson Quadruple Effect Long Tube Evaporator; Borgent & Wilbur Ammonia Disassociator; 10,000 cu. ft. per H
- Swenson Lead Evaporators with Everdur Tubes; 500 sq. ft.

SEND for NEW ISSUE of "FIRST FACTS"

FIRST MACHINERY CORP.

209-289 TENTH ST.

BROOKLYN 15, N. Y.

*Sterling 8-4673

CLASSIFIED . . .

EQUIPMENT SEARCHLIGHT

► Coverage — National Equipment and facilities—used, resale and rental—for the process industries. For sale, wanted, for rent.

► Rates—\$21.75 per inch for all

ads except on a contract basis; contract rates on request. An advertising inch is measured 1 in. vertically on a column; 3 columns, 30 in. per page. Ads acceptable only in display style.

BUY ON TERMS!

SPECIALS FROM OUR STOCK OF OVER 10,000

Sperry 30" Filter Press, 54 plates and frames. Cast iron cl. del.

ACVO Delaval Centrifuge, 12 nozzle type 316 S.S.

Link-Belt 502-16 Roto-Louvre Dryer Completely equipped

S.S. Heat Exchanger, 96 1 1/2" O.D. tubes, 144 sq ft area

Charlotte S.S. Model 20 Colloid Mill Horizontal type with 20 HP mtr

Sturtevant #2 Moto-Vibe Screen, type MU2306, 3'x6' double deck

For any item you need, wire or phone collect GA 1-1380



MACHINERY AND EQUIPMENT COMPANY

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SAVE ON GOOD USED MACHINERY

Centrifugals: 12", 30", 40" & 48".
Centrifuges: Sharples #5 & #6 Stainless
Dryers: Albright Neil 4x9 Atmos. Drum
Buffalo Vac. Drum Dryer 24"x20".
Shef. Drvrs & Rotary Dryers.
Filters: Vailex type 49 Stainless covered
leaves.
#2 Sweetland 12 Stainless covered leaves.
Filter Presses: 8" to 36" Iron & Wood.
Kettles: S.S. Jacketed, 80, 70, 60 & 50 qals.
Dopp 350 qal. cast iron Jack. Vacuum.
Devine Impreg. Units 30" & 38" dia.
Steel. Alum. & Copper 5 to 2,000 qals.
Mills: Raymond #80 Pulverizer 30 H.P.
Also #4000
Mikro Pt. Verifiers #4, 2, 1, & Banton.
Hammer & Vis & Pulverizers 3 to 50 HP.
Ball & Jewell Rotary Cutters 1 1/2 to 50 HP.
Pebble, Jar & Ball Mills, Lcb. to 6" x 8".
Steel 3 Roll 9" x 32", 12" x 30" & 16" x 40".
Lehmann 4 Roll W.C. 12" x 36" Steel
Colloid Mills Stainless Steel 5 & 1 1/2 HP.
Mixers: Baker Perkins Jack, 100 qals.
Day Imperial 75 & 150 qals. Jack.
Day Pony Mixers 8, 15 & 40 qals.
Day Jumbo 700 qal. horiz. mixer.
Elystone 3000# tank. spiral mixer.
Dry Spiral Mixer 50 to 3000#.
Lancaster 6" dia. vert. mixer 25 HP
Pumps: Stokes etc. Vac. 10 to 500 CFM.
Gould 75 HP Centrifugal 250 PSL.
Sifters: Robinson 20" x 48" Gyro. 3 open-
ings and others.
Tablet Machines: Single & Rotary Types
1/2" to 3".
Plastic Rubber Machy. Hydr. Presses.
Partial listings. Write for Bulletins.

STEIN EQUIPT. CO.
107-8th St., Brooklyn 15, N. Y.
Sterling 8-1944

MACHINECRAFT

S. S. Reactor 1200 gal. 200 lb. pressure.
Stokes 3-DDS2, 1-Y, 1-RD3, 2-B
Baker Perkins 100 gal. S.S. double arm. 80 HP
jacketed, vacuum, hyd. tilt.
Blaw-Knox 2 gal. S.S. Autoclave 5000 lb.
50 gal. S.S. Autoclave 2000 lb. press.
Billex 5 S.S. Pressure Filter.
Sweetland #2 off Stainless.
Stainless Steel Ball Mill.
Aluminum Condenser 350 sq. ft.
1-Aluminum evaporator Calandria type, never
used 1200 sq. ft. 1000 gal.
1-Baker Perkins 100 gal. double arm steel.
2-Presto & Schwartz Stand drum dryers.
Continuous stripping column 2 x 13 steel.

LOUIS SUSSMAN, INC.
800 Wilson Ave. (East of Doraville)
Newark 5, N. J.
MI 2-7634

AUTOCLAVE WANTED

3000 to 6000 gallon. Type 316 or 347 stain-
less steel, solid or clad. Will consider
glass-lined. To operate at 400 psi, and
400°F. Prefer heat coils but will consider
jacketed type.

W-9506, Chemical Engineering
520 N. Michigan Ave., Chicago 11, Ill.

WANTED

High Pressure Komarek-Greaves BRIQUETTE PRESS

with 20 1/2" diameter x 9 1/4" wide rolls
with or without feeder and pug mill.
W-9506, Chemical Engineering
520 N. Michigan Ave., Chicago 11, Ill.

Buying

Good Used Equipment

is frequently the difference between
having needed equipment or doing
without it.

LOEB OFFERINGS

Autoclave: 50 gal. Struthers-Wells, st. st.
Centrifugals: 12", 17", 20" and 25".
Clarifiers: De Leval and Sharples, st. steel.
Crystallizers: 500 gal. stain. steel, jacketed.
Dryer: Devine 2 x 4' vac. drum, st. steel.
Dryers: Link-Belt Monotube of metal.
Filters: Elmo, Oliver, Sweetland, Alsco,
 Sparkler, Industrial, Sweetland.
Kettles: St. Steel, with and without ag.
 Green 200 gal. st. st. 100# lbt.
 Green 350 gal. st. st. ASME 40# lbt.
 Dopp 150 gal. dbl. act. agitator.
Mills Mikro Bantam: 2TH or 24".
Fitz Comminuting model D: st. st.
 Day 12 x 32" 2-speed high speed.
 Day 14 x 30" type 3 hi-speed.
Colloid: 3, 5, 20 & 25 hp.
Mixers: Dbl. and Sgl. arm sigma blade.
 Dry Powder, various sizes.
 Troy angular pony 40 gal. 2-speed.
Mix-Muller Simpson Lab., Porto, #00.
Percolators: Ptaudier 54 x 42" st. st. Jack.
Pumps: Rotary, gear, centrif., vacuum.
Vacuum Pan: 42" Harris st. steel.

LOEB
EQUIPMENT SUPPLY CO.
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- 1—Acme steel bubble cap column 42" dia. with 10 trays
- 1—Downington Iron Steel bubble cap column 24" dia. with 14 trays
- 2—Patterson Kelley steel heat exchangers, 1000 sq. ft. each
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- 1—Swenson type 316 SS vacuum crystallizer, 3'6" x 12'
- 1—Swenson type 316 SS vacuum crystallizer, 2'6" x 12'
- 1—Badger type 316 SS bubble cap column, 36" dia. with 8 trays
- 1—Badger type 316 SS bubble cap column, 42" with 11 trays
- 1—Stokes Model DDS2 rotary tablet press

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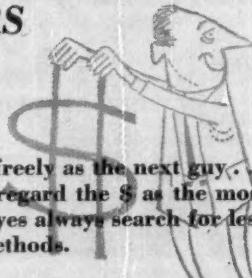
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Allegheny Ludlum Steel Corp.	41	Great Lakes Carbon Corp.	
Alloy Steel Products Corp.	1	Nerofil Products Dept.	111
American Cyanamid Co.	8-9	Grinnell Company, Inc.	14
Armstrong Machine Works	11	Hammond Iron Works	104
Atlas Powder Co. (Darco)	25	Hardinge Co.	109
Bird Machine Co.	4	International Engineering Corp.	99
Buell Engineering Co.	103	Kennedy Van Saun Mfg. & Engrg. Co.	12
Catalytic Construction Corp.	Third Cover	Marquardt Aircraft Co.	77
Cherry-Burrell Corp.	31	McGraw-Hill Publishing Co.	78-79
Chicago Bridge & Iron Corp.	39	Marsh Instrument Co.	112
Chicago Pneumatic Tool Co.	6-7	Mixing Equipment Co.	4th Cover
Crouse-Hinds Co.	18	Morehouse-Cowles Co.	23
Dean Products, Inc.		National Engineering Co.	48
Dean Thermo-Panel Coll Div.	121	New England Tank & Tower Co.	101
Denver Equipment Co.	69, 110	Nugent & Co., Wm. W.	113
Eaton-Dikeman Co.	121	Oakite Products, Inc.	100
Enjay Company, Inc.	75	Pangborn Corp.	16
German-American Trade Promotion Office	114	Patterson-Kelley Co.	20-21
Goodrich Industrial Products Co. B. F.	122	Peerless Pump Div., Food Machinery & Chemical Corp.	46
		Pittsburgh Lectrodryer Div. of McGraw-Edison Co.	10

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Prater Pulverizer Co.	114
Pressed Steel Tank Co.	13
Quaker Oats Co., Chemical Div.	33
Richardson Scale Co.	102
Rolock, Inc.	121
Sharples Corp.	15
Shell Chemical Corp.	2nd Cover
Sprout, Waldron & Co.	80
Stokes Corp., F. J.	47
Sturtevant Mill Co.	97
Swenson Evaporator, Div. of	
Whiting Corp.	35
Taylor & Co., W. A.	120
Troy Engine & Machine Co.	112
U. S. Rubber Company	71
U. S. Steel Corp.	
National Tube Div.	76
Vogt Machine Co., Henry	50
Waukesha Foundry Co.	73
Weinman Pump & Mfg. Co.	98

PROFESSIONAL SERVICES	115
CLASSIFIED ADVERTISING	
F. J. Eberle, Business Mgr.	
EMPLOYMENT OPPORTUNITIES	115
EQUIPMENT (Used or Surplus New)	
For Sale	116-119
WANTED Equipment	117
ADVERTISERS INDEX	
American Air Compressor Corp.	117
Brill Equipment Company	117-118
Callahan, John R.	115
Cog Corp., Div. of Motigraph Inc.	
The	115
Equipment Clearing House Inc.	118
Erman-Hornell, Div. Luria Steel &	
Trading Corp.	118
First Machinery Corporation	116
Gelb & Sons, R.	119
Heat & Power Company	118
Lawler Company	117
Loeb Equipment Supply Company	117
Machinery & Equipment Company (Calif.)	116-117-118
Monarch Personnel	115
Newman's Inc.	116
Perry Equipment Corp.	118
Stein Equipment Company	116
Sussman Inc., Louis	116
Union Standard Equipment Company	118

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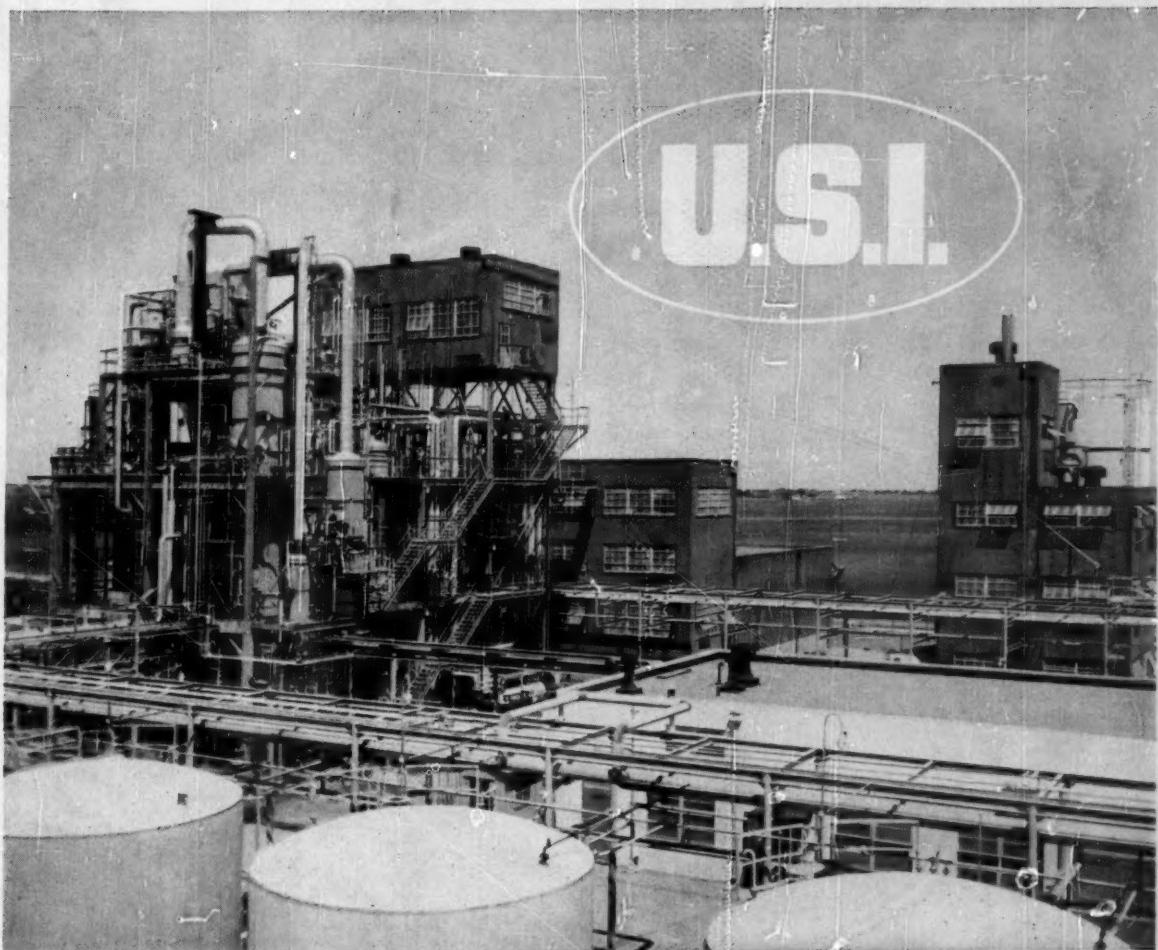
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First cost is a very small fraction of your total mixing cost.

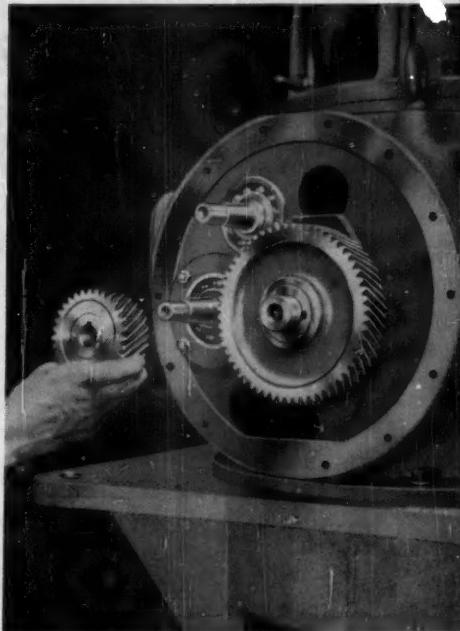
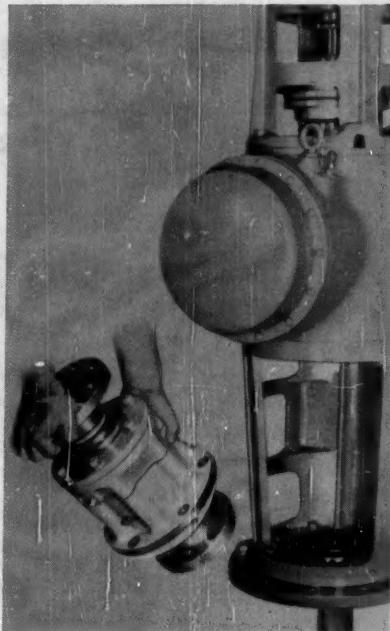
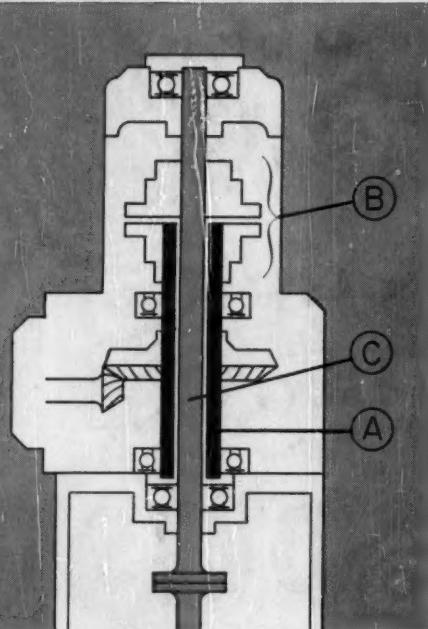
To find the *real* savings, look behind the price tag. Which mixer design will give you simplest, cheapest maintenance over the years? Most dependable month-in, month-out service? Greatest adaptability if mixing

conditions change? Lowest spare-part requirements?

These are the areas where you can *really* save money on fluid mixing. And here are some of the reasons why you can do it more surely with LIGHTNIN Mixers than with any other mixer available.

For lower-cost fluid mixing, see your LIGHTNIN representative soon. He's listed in Chemical Engineering Catalog. Or write us direct.

Only Lightnin Mixers cut your mixing costs these 3 ways



1. PROTECTED GEARING. Ever think what could happen to a mixer's gearing if something in the tank should accidentally damage the shaft? Shocks or flexures don't reach the gears in a Series "E" LIGHTNIN Mixer. Hollow quill* (A) isolates gearing from shaft. Flexible coupling (B) transmits power from gears to shaft—soaks up mixer shaft loads. Mixer shaft (C) is easily removed without risk of disturbing gear alignment.

*Patented

2. EASIER, SAFER SEAL CHANGE. Cartridge-type rotary mechanical seal† eliminates leakage under pressure or vacuum, runs for years without adjustment, and can be replaced in minutes without skilled manpower and without disturbing gearing or shaft alignment. Basis of this extra safety and convenience is the hollow quill of the reducer, which lets mixer shaft move up and down freely. You get this construction only with LIGHTNIN Mixers.

†Patent pending

3. INTERCHANGEABLE SPEEDS. Should your mixing requirements ever change (within the mixer's rated limits), you can quickly adapt your LIGHTNIN to meet the new needs. Change gears‡ provide as many as 16 standard AGMA output speeds from the same basic drive. You can change speeds without dismantling the mixer or removing it from the tank. This cost-cutting feature, like all the others shown on this page, is a LIGHTNIN "first."

‡Patented

WHAT MIXING OPERATIONS ARE IMPORTANT TO YOU?

You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- Top or bottom entering; turbine, paddle, and propeller types 1 to 500 HP (B-102)
- Top entering; propeller types: 1/4 to 3 HP (B-103)
- Portable: 1/2 to 3 HP (B-108)
- Confidential data sheet for figuring your mixer requirements (B-107)
- Laboratory and small-batch production types (B-112)
- Condensed catalog showing all types (B-109)
- Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)
- Side entering: 1 to 25 HP (B-104)

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 128-N Mt. Read Blvd., Rochester 3, N. Y.

In Canada: Greay Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

**Lightnin®
Mixers™**

MIXCO fluid mixing specialists